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Editorial 2

A Five-Valve Broadcast Vibrator Receiver 4

A Transmitter-Receiver for the 420 mc/sec. Amateur Band 9

A Versatile Pre-amplifier for Modern Gramophone Pick-ups 11

A Frequency-Compensated Three-Step Attenuator for Use with Oscilloscope Amplifiers 17

The *Radio and Electronics* Abstract Service 21

A New Way of Using 807's—120 Watts of Audio 27

Questions and Answers:
How an Ordinary Shunt Rectifier Works 29

The "New High-Quality Amplifier" Again 31

For the Serviceman: The Columbus Model 42 32

New Zealand Radio Manufacturers' Federation Notes 34

Annual Meeting of the Auckland Radio Traders' Association 35

The New Zealand Electronics Institute (Inc.) Newsletter 36

Publications Received:
Essentials of Radio, by Slurzberg & Osterheld 38

Our Gossip Column 42

The Philips Experimenter:
No. 24: A Miniature M.O.P.A. Transmitter for Battery-Operated Transmitters or Transmitter-Receivers 44

OUR COVER

This month we feature a view of the 420 mc/sec. transmitter-receiver which is described in this issue. It is shown together with its plug-in aerial and the microphone and headphones, from which its diminutive size can be gauged.

AN APOLOGY

Readers of the Philips Experimenter will note that this month's edition does not continue with the description of the modulator for the 100-watt transmitter. We wish to apologise to those who have been following this feature, and to assure them that the omission is one that is outside our control and that the series of articles on the transmitter will be continued next month.

●

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GUY E. MILNE
ELECTRONIC TECHNICIAN

BRITAIN AND THE EXPORT MARKET

Since the devaluation of the pound sterling only a short time ago, there has been a great deal of talk in the daily Press as to just how far the devaluation will assist Britain to expand her dollar earnings. There has also been a goodly amount of well-meaning criticism, designed not destructively, but to assist still further in bringing the Old Country out of the difficult situation in which she now finds herself.

One small paragraph that readers of this journal may have noticed was, we thought, extremely significant, and broached one aspect of the situation that does not seem to be given sufficient thought, both by Britain's friends and well-wishers and by her own manufacturers. The thesis of the paragraph to which we refer was that, whatever is done, and done successfully, to increase British production and to reduce costs (themselves absolutely essential objectives), all will be in vain if the articles manufactured for export to dollar areas are not really suitable for their intended markets.

We ourselves have very recently had experience of how badly unsuitability of a product can affect its overseas sales prospects. The case was one involving a British manufacturer, and is worth relating because of the seriousness of its implications.

The equipment was a tape recorder—not of the ordinary sort, but one specially designed to work in conjunction with a sub-standard moving-picture projector, and its purpose in life is to enable the owner of a silent movie outfit, either 8 or 16 mm., to record and play, simultaneously with the projection of his picture, a spoken commentary, with or without background music. This is undoubtedly a very fine idea, and one which should enable a great deal of business to be done, assuming that the device is well planned and executed. By this, we mean that the tape recorder must be efficient in itself and must be suitably designed to enable non-technical people to operate it, in conjunction with their movie projectors, with complete satisfaction to themselves. Unfortunately it was due to the manufacturer's having fallen down in this respect that we were brought into contact with the recorder at all. The owner was a photographic firm which does considerable business in amateur movie equipment, and a member of which, at present in England, had rightly decided that the recorder should be an excellent accessory to have for sale. He had sent the recorder out to this country, together with the booklet of operating instructions. The firm, having received it, proceeded to put it into operation, and, being completely non-technical as far as sound equipment is concerned, had carried out the maker's instructions to the letter. The trouble was that, having done so, the results were far from good, and, since the article had had excellent Press notices in the United Kingdom and was made by a reputable firm, the users decided that there must be something wrong with it, and asked if we would listen to its performance and make some sort of pronouncement on it. We did so, and came to the conclusion that there was nothing organically wrong with it at all, but that the bulk of the trouble was due to lack of understanding of the recording and playback process by the users.

Briefly, the poor results seemed to be due to two things. First, the gear contained neither automatic gain control nor any level-indicating device, and, secondly, the instructions recommended certain settings of the gain controls which were entirely unsatisfactory. The instructions did not even recognize the fact that the gain setting, when music is being recorded from a gramophone pick-up, is entirely dependent upon the type of pick-up used. As a result, the purchaser was utterly failing to operate the machine satisfactorily, **and not due to a fault in the equipment as designed.**

It seems to us that the designers made a very bad mistake in not doing one of two things—providing a level indicator of some sort, with suitable instructions as to its use, or, in its absence, writing the existing instructions in such a way as to indicate to non-techical users that the successful use of any recording device depends upon satisfactory control of the recording level and explaining the effects of too much and too little "volume" during the recording process. Armed with such information, the users of the gear in question would have had no difficulty in making the recorder work well. As a result of what appears to be lack of appreciation on the part of the makers of the point of view of the non-technical user, at least one possible outlet for the maker's production has formed a poor opinion of what is basically a fine idea, well executed.

While we have nothing but admiration for British technical development and for much British equipment, the fact remains that much of it seems to suffer in ways similar to those we have described in the case of the tape recorder. Such criticism as we have made in this instance is, we hope, constructive, and, taken in conjunction with warnings already issued overseas, the point at issue is one of the utmost importance—not only in the electronics field, but in many others besides.

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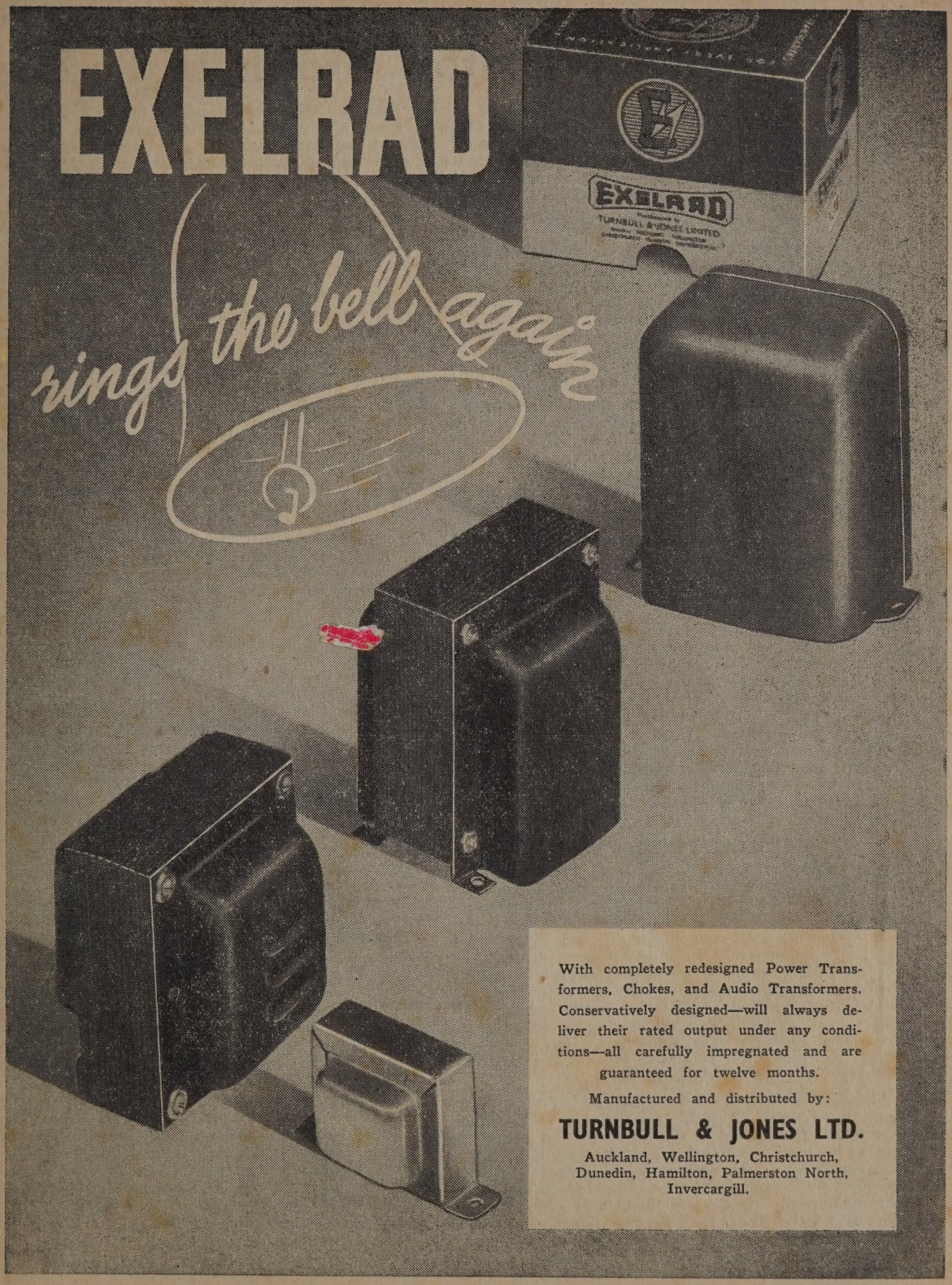

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A Five-Valve Vibrator Broadcast Receiver

With the summer almost upon us, now is the time for those radio enthusiasts who are also launch or caravan owners to start thinking about a receiver for installation before the season really gets under way. Since most launches and caravans already possess accumulators for other purposes, the logical choice of power supply is the vibrator. This set therefore makes use of one of the complete ZC1 vibrator power supplies that are available on the retail market at a very reasonable price.

INTRODUCTION

Until the advent of the vibrator, which enables a high-voltage D.C. to be obtained from a low-voltage battery as the prime source of energy, the only really practicable source of power for radio receivers that were not to be worked from the A.C. mains was the dry battery. Dry battery sets have been brought to a high degree of perfection as far as performance is concerned, but in spite of the use of Class B output stages, which materially reduce the B battery drain, the operation of such a set is an expensive business. Also, the batteries take up a deal of room, and in boats and caravans this is not a commodity that can be spared to any extent. The vibrator set, however, takes up no more room than a similar A.C. set would do, since it can be assumed that the accumulator does not have to be specially installed for the purpose, and, even if it does, it can be placed out of the way. More important than this, however, is the fact that the running costs are low. In fact, where battery charging facilities already exist, as in most cases they do, the cost can be reckoned as nil. Normally, though, a vibrator set is quite an expensive one to buy or to build, because of the additional cost and complexity of the vibrator power supply as compared with a normal A.C. power pack, but with ZC1 power supply units available at a very reasonable price this need not deter the intending builder so much. The ZC1 unit is arranged for a 12-volt D.C. input, and, of course, will not work from a 6-volt battery, so that the set as it stands is suitable only for situations where a 12-volt accumulator is on hand. However, as there are many cars and launches equipped with 12-volt electrical systems, we have felt that a description of ZC1-powered set is well worth while.

GENERAL DESCRIPTION

We would like to emphasize from the outset that those who have never built anything but A.C. operated sets need have no fear that there are any great difficulties to be encountered in building this set. The main difficulties to be encountered in any vibrator set are those connected with the proper filtering of vibrator "hash," and this is almost entirely a matter of proper design of the power supply unit. Since we are to use a built-up power supply unit, these difficulties have already been taken care of in advance. The set is thus no more difficult to wire or to get going than a simple six-valve broadcast set of the ordinary mains-operated variety.

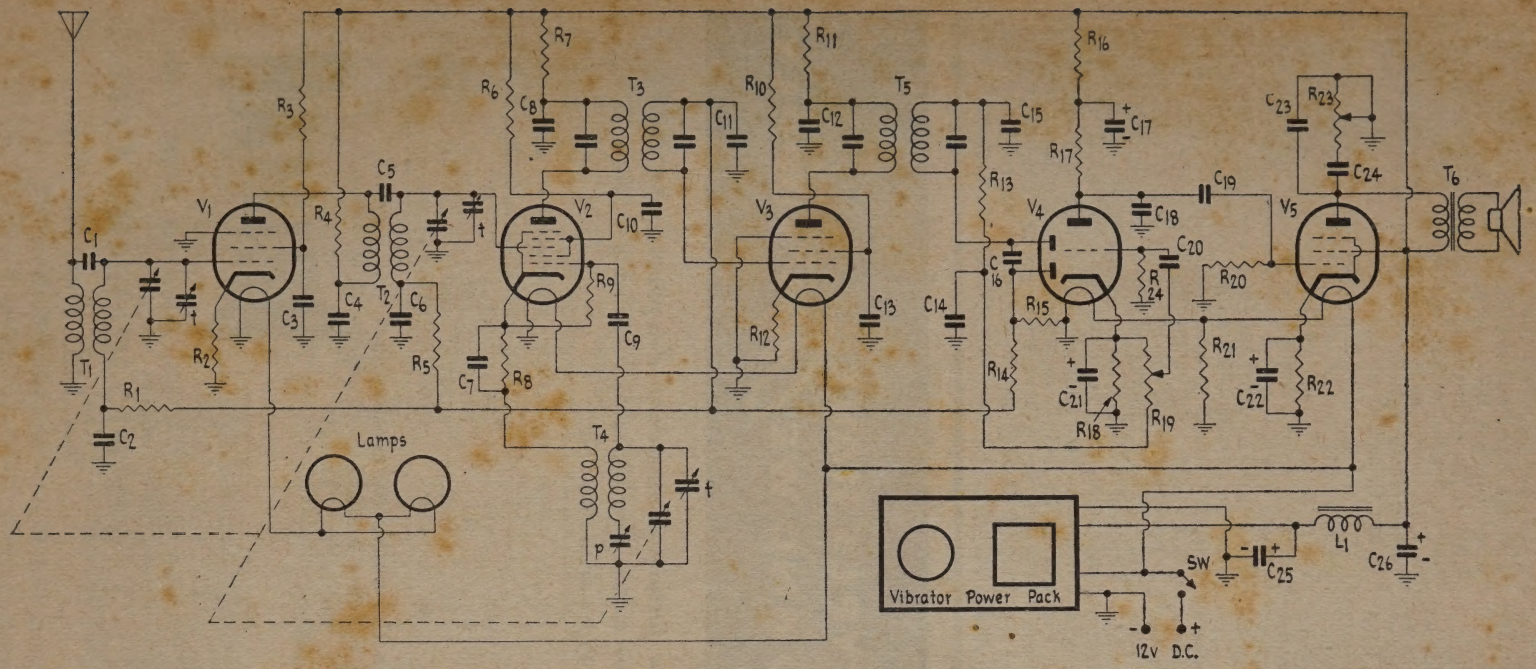
The set has only five valves, but, seeing that a synchronous vibrator is used, all these are "working" valves, and the line-up is similar to that of a conventional six-valve broadcast set. It has an R.F. stage, oscillator-mixer, I.F. stage, second detector, A.V.C. and first audio valve, and a single-ended output stage. The performance is thus equivalent in every way to that of a six-valve broadcast set, since the valves used are all normal A.C. types, even to the output stage, which uses a 6V6, with full voltages, and an output of 4 watts or so in the ordinary way.

To make the set as modern in design as possible, and to ensure high sensitivity, the latest types of A.C. miniature valves have been used in all positions except the output stage. 6BA6's are used as R.F. and I.F. amplifiers, a 6BE6 is the oscillator-mixer, and the second detector, first audio, and A.V.C. valve is a 6AV6 miniature double-diode-triode. Since these valves have much higher mutual conductance, and therefore greater gain, than the older full-sized or metal valves, the set can adequately be described as a "hot" one, but, in spite of this, it was found that complete stability was easily achieved, even without the use of baffle-shields across the sockets of the R.F. and I.F. stages. We realize that some constructors are not very keen about using these miniatures, because of their single-ended construction, but our own experience of them is that they are very easy to "sit down." Certainly, the full gain of which the R.F. and I.F. stages are capable was not made use of, but here we are in good company, as the manufacturers themselves do not recommend their operation under maximum gain conditions on the broadcast band. In fact, on looking through the pages of the latest issue of "Radiotronics," where much application data has appeared on these valves, we find that only in F.M. sets, where the frequencies are high and the bandwidths great, is the 6BA6 used with its recommended minimum cathode resistor, and therefore at full gain. Seeing that the Gm of the 6BA6 is at least twice that of a 6SK7, it is clear that a good deal of amplification can be dropped without reducing the overall gain of the set below a normal figure. Incidentally, the miniature types we have used in this set show signs of becoming standardized as the most commonly used American types for new set production, so that there is considerable virtue in using them, apart from their purely technical advantages. Not the least advantage is that they will be constantly available from Australian production, so that they are unlikely to become unavailable for many years.

The 6BE6 is an oscillator-mixer valve of the 6SA7 type, with no special oscillator plate electrode. This means that the oscillator circuits that can be used are rather limited in number, but not that standard oscillator coils made for other valves cannot be successfully used. In fact, there may be some difficulty in obtaining tapped oscillator coils in this country, unless coils designed for the 6SA7 can be had, but in this set the difficulty was satisfactorily overcome by using the plate winding of a normal oscillator coil in the cathode circuit of the 6BE6.

The 6AV6 is very similar to other double-diode-triodes, and does not need any departure from conventional circuitry to make it work. The triode section is a high-mu one, and has ample voltage output for exciting the 6V6 as the output stage.

Because we are using a made-up vibrator power supply, this has been represented on the diagram simply by a block with four leads issuing from it. These are two for the 12-volt input and two for the



COMPONENT LIST

V_1, V_3, 6BA6.
V_2, 6BE6.
V_4, 6AV6.
V_5, 6V6 or 6V6-GT.
C_1, C_5, 10 $\mu\mu$f. silvered ceramic.
C_2, C_3, C_4, C_6, C_8, C_{10}, C_{11}, C_{12}, C_{13}, 0.1 μf. 600v.
C_7, C_{19}, C_{20}, C_{24}, 0.05 μf. 600v.
C_9, C_{16}, 50 $\mu\mu$f.
C_{14}, C_{15}, C_{18}, 100 $\mu\mu$f.
C_{17}, 8 μf. 450v. electro.
C_{21}, C_{22}, 25 μf. 25v. electro.
C_{23}, 0.004 μf. 600v.
C_{25}, 16 μf. 450v. electro.
C_{26}, 40 μf. 450v. electro.
R_1, R_5, 100k.
R_2, R_{12}, 100 ohms ½ watt.
R_3, R_{10}, R_{13}, 50k.
R_4, R_7, R_{11}, 2k.
R_6, 15k.
R_8, 150 ohms ½ watt.
R_9, 20k.
R_{14}, R_{15}, 1 meg.
R_{16}, 25k.
R_{17}, 250k.
R_{18}, 3k.
R_{19}, R_{23}, 500k. pot.
R_{20}, 500k.
R_{21}, 42 ohms.
R_{22}, 250 ohms.
R_{24}, 1 meg.
T_1, aerial coil.
T_2, R.F. coil.
T_3, T_4, I.F. transformers, 455 kc/sec.
T_5, oscillator coil.
T_6, output transformer, 5000 ohms to voice-coil.
L_1, 60 ma. smoothing choke.
Lamps, 6.3v., 150 ma. each.
t, trimmers.
p, padder.

250-volt output. This makes the power supply wiring a good deal less than when a normal power transformer is used.

THE CIRCUIT IN DETAIL

The circuit of this set has been purposely made as straightforward as possible and as similar as we could make it to that of an ordinary A.C. receiver. Most of the departures from usual practice have been indicated already in the previous section, and in any case these are only slight. The method used to reduce the gain of the R.F. and I.F. stages to manageable proportions is to use cathode resistors somewhat higher than the minimum value, and in addition to leave them unbypassed, giving each stage a small amount of negative feedback.

The aerial and R..F coils are standard components with high-impedance primary windings; these have a small condenser of 10 $\mu\mu$f. connected between the "hot" ends of the primaries and secondaries—a connection that is not always seen in circuit diagrams. Some coils have a small condenser of this nature built into them, and others use a small winding of a few turns, connected to the primary at one end but unconnected at the other, to act as a minute condenser in this way. The brand of coils purchased for this set is one in common use in this country, and with these coils the 10 $\mu\mu$f. condenser is supplied with the coils, but not wired into place. It can be wired between the appropriate coil lugs before the latter is placed in the set. Should a different make of coil be bought, of the kind which has this capacity built in, either as a condenser or by means of the extra winding mentioned above, there will be no need to use C_1 and C_5 at all.

A word as to the purpose of these condensers might not be out of place at this point. The average aerial or R.F. coil, which these days almost always employs a high-impedance primary, gives a much greater voltage gain at the low-frequency end of the band than at the high-frequency end. Thus, a set made from coils which do not use this added capacity will have much greater sensitivity at the low-frequency end than at the high-frequency end. But if a small condenser of 10 $\mu\mu$f. or less is connected as are C_1 and C_5 in the circuit of this set, this has the effect of allowing more voltage to be transferred to the secondary, by capacity coupling, at the high-frequency end than at the low-frequency end of the band. In fact, if capacity coupling alone were used, the set would have much greater sensitivity at the high-frequency end, which is just the reverse of what happens with a high-impedance primary on its own.

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6.3-volt Octal Types	6K7GT	6K8GT	6K7GT	6B8GT	6V6GT	5Y3GT
6.3-volt All Glass Types	6BA6	6BE6	6BA6	6AT6	—	6X4

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Thus, the two sorts of coupling are opposite in their effects as far as gain over the band is concerned. When they are both used at the same time, it is possible so to proportion the inductive and capacity coupling that the gain of the set is almost constant at all parts of the band. It should be understood that the effect we are discussing has nothing at all to do with proper tracking of the superheterodyne part of the circuit, as it concerns only the T.R..F part. This added capacity is known as "top-capacity coupling," and is very well worth while.

The oscillation coil is T_4 on the circuit diagram, and it should be noted that **it is a standard component, originally designed for use with a 6K8 oscillator-mixer tube.** There is a very important point about the connection if this oscillator coil is in the circuit. To emphasize this, we are printing it in capital letters. It is this: THE END OF THE TICKLER WINDING THAT NORMALLY GOES TO THE OSCILLATOR PLATE IS CONNECTED TO EARTH. This is the opposite way round to normal, and the reason for it is not far to seek. It is well known by constructors that if a load impedance is placed in the cathode circuit of a valve, as well as in the plate circuit, the phase of the current through the load in the cathode is opposite to that of the load in the plate circuit. Now, since this coil was meant to have its tickler in the plate circuit of the oscillator, its terminals are indicated in such a way as to cause the R.F. current in the tickler to give regeneration, and therefore oscillation. If, then, we take this coil and connect it so that the tickler is in the cathode circuit of a valve, any R.F. current that passes through the tickler will be in the wrong direction to give positive feedback, and will oppose oscillation instead of causing it. We must therefore reverse the tickler leads so that the one that was the "hot" is now the "cold" one, and by so doing we have reversed the phase of the R.F. current through the tickler and given ourselves back the required conditions for oscillation.

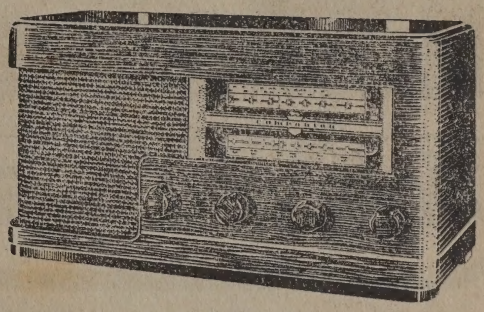
It will be noted that the cathode resistor, bypassed by an 0.05 μf. condenser, is connected between the cathode of the 6BE6 and the cathode winding of the oscillator coil. In this way, the correct D.C. grid bias is supplied in the ordinary way without at all affecting the operation of the oscillator. This is due to the fact that R_8 is bypassed by C_7, with the result that, as far as signal and oscillator voltages are con-

(Continued on page 41.)

DUAL WAVE

5 or 6 VALVE

with COMPANION



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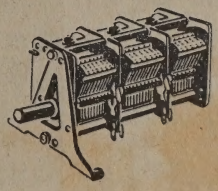

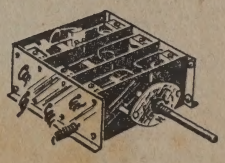

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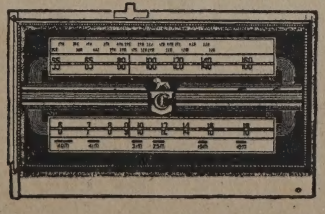

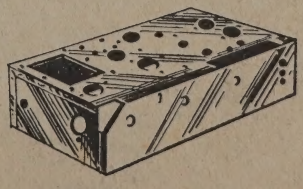

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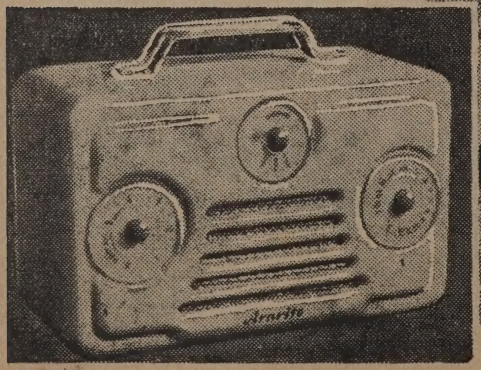

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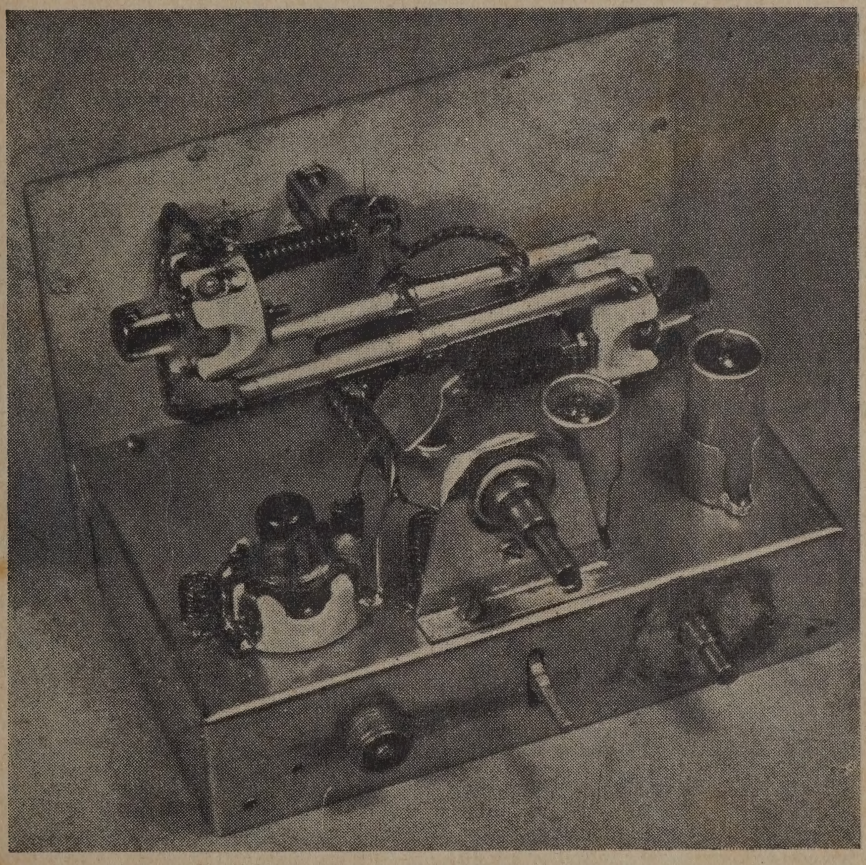
A Transmitter-Receiver for the 420mc/sec. Amateur Band

Since January of this year, amateur transmitters have had available to them a number of frequency bands in the very high and ultra-high ranges. As far as is known, no New Zealand publication has yet featured any equipment capable of operating on the bands above 144 mc/sec., and so we are breaking new ground with this description of a complete mobile station on the 420 mc/sec. band. This gear has been designed and built in our own laboratories, and has been tested in the field with very satisfactory results.



General view of the inside of the transmitter-receiver. The transmitter consists of the two-valve oscillator mounted on the back panel, while the super-regenerative detector is the 955 in the front left-hand corner.

INTRODUCTION

There is a sort of fascination about equipment that works on the higher frequencies, between what are known as very high frequencies and the so-called microwaves. In this region, it is still possible to build and operate receivers and transmitters without using valves that cost the world unless they can be "scrounged" or bought from war assets stock, and it is safe to say that the same techniques that were still in common use on five metres before the late war can now be used with very little difficulty and the knowledge of only a few special "tricks" up to the 420 mc/sec. amateur band at the very lowest. Triodes, in particular, will still oscillate and act as both low-powered transmitters and super-regenerative receivers, and although there are one or two pentodes that can work as R.F. amplifiers at this frequency, they have just about given up the ghost here and are to be avoided until some experience has been gained.

We have often sung the praises of V.H.F. and U.H.F. as the ideal playground for the experimentally inclined, and, to our way of thinking, the playground becomes broader and the scope for inexpensive and satisfying messing about wider the higher one goes. There is no doubt about the fact

that aerial experiments become a pleasure instead of hard work when a quarter-wave vertical is only seven inches long, and a half-wave dipole only 14 in. And there are few things more entertaining (or instructive) than building up a complex array out of the book and seeing what it actually does with the aid of a crystal detector and a milliammeter.

Then, on the communication side of the business, there is much fun to be had by working a mile or two, or even more, with midget equipment and power outputs to be reckoned in milliwatts rather than in watts, especially when, if you get in smartly, you can still claim to be the first in your district to have built and successfully operated equipment on such a high frequency.

We ourselves have had no small degree of pleasure from designing and building this equipment, our only wish being that we could devote more time to work like this. But it would hardly do if "Radio and Electronics" were to become full of nothing but U.H.F.!

However, the idea with which we undertook the job of starting off on 420 was more that, by so doing, we could show the way to some who might have been hankering after something in this line that is not too difficult to build, but which works nevertheless, and who want a design that can be built with valves that are available here.

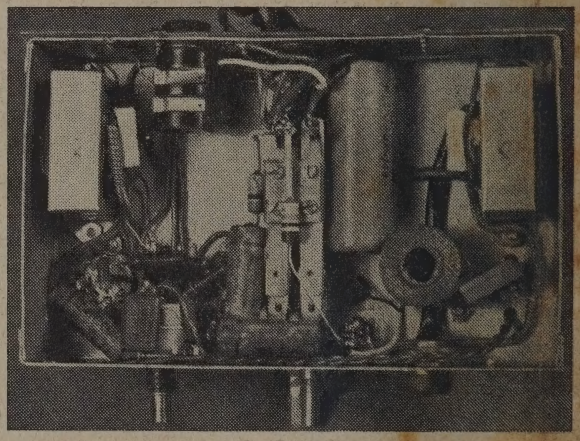
The R.F. end of the whole thing is built round the old 955 acorn tube, which has many virtues, not the least being that quite large numbers of them seem to be about at give-away prices, especially when the pre-war price of more than £2 each is remembered!

GENERAL SCHEME OF THE EQUIPMENT

Although it is not our habit to build or recommend to readers transmitters consisting of simple modulated oscillators, we see no reason why such a transmitter should not be used on the 420 to 460 mc/sec. band, at least at this early date. This band is 40 mc/sec. wide, and is thus more than 20 times wider than the 10-meter band. It can truthfully be said, therefore, that there is any amount of room, even for signals which suffer from unintentional frequency modulation, as do all modulated oscillators. In getting away from crystal control, or even from M.O.P.A. transmitters for our first experiments on this band, we are doing no more than has been done on all the lower bands in turn. There was a time when even 80 metres was wide enough to accommodate broad signals, and there will undoubtedly be a time when crystal control will be a "must" on 420, but that day is a long way off yet, and the first essential in getting going on a new band is to get going, so that, with full knowledge of the limitations of the type of gear we are recommending initially, we make no further apology for the fact that we have gone the self-excited way with the transmitter or have retained the super-regenerative principle for the receiver.

The first essential, then, has been regarded as having a transmitter which will produce enough power to enable communication to be effected over at least a mile or two. Further, since 420 mc/sec. equipment can be made so small and portable, we have designed the whole equipment mechanically so that it is as small and as light as possible. The photograph on the front cover shows the main unit, complete with aerial, and sitting beside the headphones and carbon microphone to give a relative idea of its size. This photograph, though impressive in its way, does not tell the full story, because the power supply is not shown. This consists of batteries, 90 volts being used for the B supply of both transmitter and receiver, and 6 volts for the heaters and filaments. This 6 volts can be got from four No. 6 cells in series, or from a motor-cycle accumulator, which is heavier but less bulky, but if the gear is to be used at a fixed location this will not be a consideration. For short spells of working, it should be possible to use two cycle lamp batteries in series as the A supply, in which case the gear will be eminently portable, since the batteries will then be accommodated in a box no larger than the one which contains the transmitter and receiver. Thus, the equipment is quite suitable for either fixed or mobile operation. If it is to be worked from a car, there is no reason why the car's battery should not be used to supply the relatively small drain of 0.5 amps. that the heaters and filaments need.

The transmitter consists of a pair of 955's, in a special line circuit that allows two valves to work as



Underneath view of the Tx-Rx, showing the phone jack at the back and the positions of the two transformers, T_1 and T_2, whose functions are described in the text.

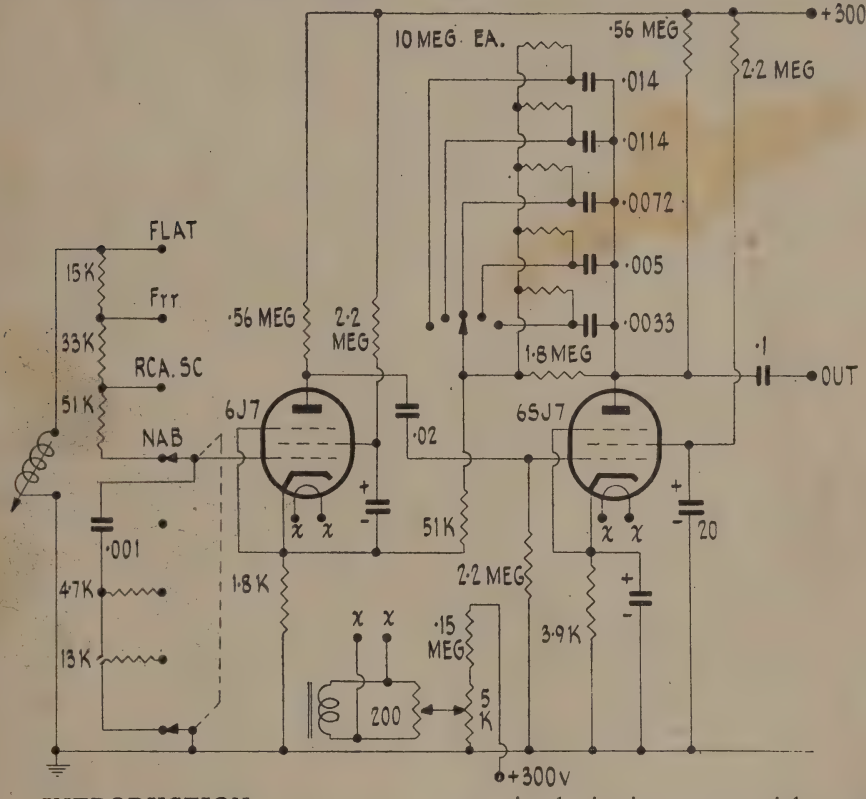
efficiently as an oscillator at the high radio frequency concerned, as will one. The circuit, which we have not seen published anywhere else in amateur literature, also has the advantage of allowing reasonably long lines to be used, and this fact makes the construction and frequency adjustment much less tricky than many other circuits are. At the same time, unlike some 420 mc/sec. oscillators that have been described for amateur use, no mechanical work is involved that is outside the scope of the average amateur workshop to produce.

The receiver is entirely separate from the transmitter, and consists basically of another 955, used as a super-regenerative detector. There is a very good point in this, as it removes the gear from the "transceiver" class. The latter type of instrument is in many respects an abomination. There is no doubt that the same circuit, with only very simple switching arrangements, can be used as the transmitter or the receiver in the time-honoured way of transceivers. There is also no doubt that the efficiency of both parts need not suffer through their use in this way, but, even so, the transceiver is really a nasty piece of work compared with the arrangement that

(Continued on page 39.)

A VERSATILE PRE-AMPLIFIER FOR MODERN GRAMOPHONE PICK-UPS

The many varieties of modern light-weight gramophone pick-up that are now on the market all have one thing in common—the need for a pre-amplifier to bring their output level up to that of the older types which had far greater output voltage. At the same time, it is essential to equalize the response to take care of the low-frequency drop purposely introduced into all records. The pre-amplifier described here performs both these functions, and also provides four degrees of high-frequency roll-off, to take care of worn records or those with high-frequency pre-emphasis.



INTRODUCTION

In case anyone might think that the subject of gramophone record reproduction is a more or less static one, with little technical interest once the enthusiast has built himself a good amplifier and has invested in a good loudspeaker and pick-up, the manufacturers of audio equipment have continued to develop better units, more particularly in speakers and pick-ups. In fact, it is possible nowadays to achieve a quality of reproduction that was undreamed of ten years ago (outside picture theatres and the like) at a price that the average builder can well afford to pay. At the same time, these developments have brought with them the need for a better understanding by the user of the problems of audio design, and have increased the interest to be gained from the technical side of the subject at the same time as they have improved the results. In a way, this has been the cause of much disappointment in cases where the users of this new gear have not fully understood all the factors involved. A modern gramophone pick-up improperly used with respect to its associated circuits can certainly sound very much worse than the common or garden variety of cheap pick-up that most people used before the war, through sheer necessity. It is hoped that our pages may have contributed in some small way to increasing many readers' knowledge of these matters, and at the same time added to the pleasure to be derived from the building and listening parts of audio work, and it is in the hope that we may still do so that we present this pre-amplifier circuit.

The design is not original with us. It is taken directly from the pages of an American contemporary, "Audio Engineering," which is not very well known in this country but which deserves to be better so. When originally published, it was intended to fulfil a need that hardly exists here—namely, that of providing a pre-amplifier that would compensate for the response characteristics of several kinds of records that are on sale in America. Here, some of these types do not exist, but the unit is none the less useful, because the varying boost that is required for these different types of record can very usefully

be applied here to give an excellent stepped type of control, which gives the user a fairly wide choice of boost characteristics. This variety can be used experimentally in order to arrive at the best setting for the records one has—a statement that almost gives the lie to the previous one that the same variety of recording characteristics does not exist among the records we can buy here—but not quite.

Before going on to describe the circuit itself, it would perhaps be advisable to resolve this seeming paradox.

MORE THAN ONE RESPONSE CURVE

Let it be said, before someone tells us that we do not know what we are talking about, that the gramophone records sold here DO have a variety of response characteristics. We have just said the same thing about records available in America. Where, then, is the difference

In the United States of America there are not only the standard commercial records, which revolve at 78 r.p.m., but also long-playing records of two kinds, one of which turns at 33⅓ r.p.m. and another at 45 r.p.m. To make matters worse, all these three types have different response characteristics, and in some of them there are a number of different characteristics to be found. However, to make things not quite so bad, these various response characteristics are published by the manufacturers, so that it is possible to arrange a reproducing system to suit any particular style of record absolutely. It is also possible to make a multi-purpose response-compensating unit, such as we have here, which will give the playback equipment the right response for a number of different types of record by means of a little simple switching.

Here, however, we are not yet blessed with commercially available discs of the long-playing types, so that it would appear at first sight that our problem is simplified. Such, however, is not the case, and here is the reason for it. All our actual discs (or at any rate most of them) come from the United Kingdom. Although the labels still bear a variety of brands, it is general knowledge that the record-making business is now a vast combine, and that the different brands are a survival from the days when each brand meant a separate manufacturer. The trouble is that, to an extent, this is still true today, in that the connection between the old companies is in some cases purely financial, with the result that individual manufacturing methods have been preserved. As a result, there are almost as many (if not more) recording characteristics to be found in records purchased today as there are types of label. One reason for this has already been given. Another is that, as recording systems have improved, so some of the response characteristics have been changed, and yet old recordings which retain their popularity are still used, side by side with those made by the most modern techniques. Another reason is to be found in the exchange of master recording dies between England, America, and Continental manufacturers. The two latter have frequently used different response characteristics from the British companies. As a result of all these factors, and possibly others as well, our records have a wide variety of characteristics. This is not of itself such a bad thing, though it is bad enough, but the real trouble comes from the lamentable fact that there is no means (save for one notable exception) by which the user can tell which characteristic the particular record was made with. There has always been a singular reluctance on the part of British manufacturers to issue the essential technical data which would enable those with the necessary knowledge to make the best possible use of their products. Thus, the position we are in is such that all we can do is to provide some bass boost for our reproducing system and hope that it will suit most of the records we have. Some of them may have to be heard only once for us to know that the characteristic we have does not suit them at all, so that we feel impelled to insert a variable boost control at the bass end so that we can have what is apparently too much or too little boost at will.

There are other things to be taken into consideration as well. The most important one is that a comparatively new development, high-frequency emphasis, is now coming to be used in commercial recordings. This is a very effective method of reducing the apparent surface noise of a record, and has been used for a long time in special records, known as transcription discs, that have been made only for use in broadcasting studios and the like, where proper compensation can be effected. In America, the long-playing records that are not yet available here also use this system of noise reduction. Briefly, it consists in boosting the high-frequency response when the record is made, and then, during play-back, inserting a corresponding degree of high-frequency attenuation, so that the overall effect is a flat high-frequency response.

We ourselves have had a strong feeling for some time that a similar scheme has been used in some

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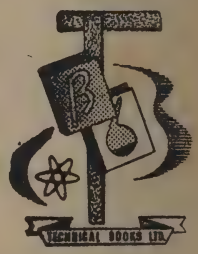

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commercial recordings, but the lack of technical information about these records has prevented any accurate knowledge of this. In many cases, such as in radio broadcasting, where practically everyone is provided with a tone-control of the top-cut variety, and also in most commercial radio-gramophone combinations, where the same sort of thing is provided, any high-frequency pre-emphasis that is on the recording does not matter very much, but when really good pick-ups and loudspeakers are used that make no bones about reproducing the upper registers, the presence of unsuspected top boost on the record can make it sound very "scratchy" or thin, even when the correct amount of bass boost is in use. In short, it is almost essential to have some sort of control over the high-frequency response of a system, especially when it has any pretensions to giving high-fidelity results.

A further point that is infrequently lost sight of, and which is again the cause of much disappointment with high-quality equipment, is that very often such gear is TOO GOOD for some of the records which it has to play. The slightest bit of "hash" or surface noise more than can be considered normal will show up when a low-distortion system is used, which has also an extended high-frequency range, and very frequently the only way to make the record in question sound at all acceptable is to cut the high-frequency response of the amplifier to a greater or lesser extent, depending on the badness of the recording. It should be pointed out, however, that blame should not necessarily be attached to the recording companies for such a state of affairs, because very often the offending record is one made many years ago, before recording technique reached its present pitch, or it may be a once perfectly sound specimen which has been ruined for high-quality purposes by a too-heavy pick-up or a single bad needle.

All the above thoughts show the desirability of having some means of altering at will both the high and low-frequency response of a record-reproducing system. We have assumed that the reader is aware of the necessity for bass-boost when a modern pick-up is used, but just in case there are some who are new to these things, we can briefly describe the reason underlying this need. Basically, it is due to two facts. Firstly, all commercial records are made with a dropping response at frequencies below some fairly low one which is called the cross-over frequency. Above the cross-over frequency, the response of the record is flat. Below it, there is a gradual and predetermined drop in response. We are more concerned here with the existence of the drop than with the reasons behind it, and it will be enough here to say that it enables a much higher level of recording to be used at the high-frequency end of the scale than if the response were flat over the whole musical scale. The remaining reason for requiring bass boost in our own gear is that the modern light-weight pick-ups that we have referred to in the heading to this article have a flat response right down to the lowest frequencies that are recorded. The result, then, if a standard record is played with one of these pick-ups without any bass compensation, is that the overall response would correspond exactly to that of the record, and the result would be very much lacking in bass. Hence a good deal of the disappointment referred to earlier.

One question that will no doubt arise is: "Why did not the older and poorer types of pick-ups require bass boost in order to have enough bass in conjunction with the record?" The answer is simply that these pick-ups made use of resonance—usually the mechanical low-frequency resonance of the arm—to give an artificial and uncontrollable boost to the bass of the record. Most often the bass boost so obtained was too great at some frequencies and not enough at others, so that the total result left much to be desired and was not very amenable to further treatment. The good pick-up, however, with its flat response, is very easy to equalize. In fact, the equalization is not really a function of the pick-up at all in this case, but only one of the drop that occurs on the record.

WHAT THE PRE-AMPLIFIER DOES

The circuit shown on the first page of this article does two things. It provides five different degrees of bass boost, which are selected at the turn of a switch. It also provides four different degrees of high-frequency roll-off, which can be used, as indicated above, for cutting out hash and excessive record noise from poor recordings, or for de-emphasizing the high-frequency components where these have been pre-emphasized during recording. The top-cut circuit is to be found at the input to the amplifier. The top switch position gives no cut-off at all, while the other three positions give slightly more at each one. The cut in the two middle positions is limited by the lower resistors in series with the 0.001 μf. condenser, but in the lowest switch position there is no limiting resistor, and at some very high frequencies the response is reduced to zero. These switch positions should not be confused with a simple top-cut type of tone control, since their effect is quite different. With this control there is no possibility of cutting off altogether all frequencies above a certain point, as there

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is with the ordinary tone-control type of circuit. In the two upper positions, the response drops, and then reaches a level again, without ever disappearing altogether.

The bass boost part of the circuit works on the now well-known principle of selective negative feedback That is to say, the two-stage amplifier has a large amount of negative feedback at all frequencies down to a certain point, at which the feedback starts to decrease, and does so progressively down to below the audio range. Because the feedback is decreasing at low frequencies, the amplifier gain is rising, and the circuit values are arranged in such a way that the full gain of the amplifier is reached at about 15 c/sec. The point at which the gain starts to rise corresponds to the cross-over frequency of the record, so that the overall result is a flat characteristic at all frequencies. By putting in different values of condenser in the feedback chain, it is possible to make the boosting effect start at different frequencies, and so give the pre-amplifier different degrees of boost. Apart from the feedback circuit, the amplifier is a simple two-stage affair using two small voltage-amplifier pentodes. It might at first appear that the gain would be exceedingly high, but the amount of feedback is so great that the voltage gain at middle and high frequencies (where there is no boost) is only of the order of 25 times. Thus, as well as providing response compensation, a medium amount of voltage amplification is given as well, to allow for the fact that the modern pick-up is a low-output device as well as a high-quality one. This amount of amplification is enough to bring the output up to something like the level obtained from the cheaper pick-ups with the higher output voltages. The purpose of the 10 meg. resistors shunted from the feedback condensers to the common arm of the switch is to allow all the condensers to be at the same D.C. potential and so to eliminate nasty thumps in the speaker when the switch is operated, due to the charging of the condensers.

CIRCUIT VALUES

The circuit is given here exactly as in "Audio Engineering," and it will be noted that some rather odd values are shown, especially in the resistors. The reason is that most of them belong to the "preferred values," about which we published a short article

Beacon Technical Topics No. 17

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Summing up, then, and neglecting the latter effect, which is serious only in *very small* transformers, we draw the following conclusions:—

(a) In transformers, high efficiencies can usually be obtained owing to the absence of moving parts.

(b) Small transformers are usually designed to have the same temperature rise as their larger counterparts, which automatically results in a lower efficiency.

(c) Small transformers *can* be designed to have efficiencies approaching that of larger ones, but this means an increase in physical size and cost for a given load.

(d) For small transformers, unless a very high efficiency is required for some specific purpose, the increase which is made results in a lower temperature rise at the expense of not making the most economical use of the materials used in construction.

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some time ago. If only the old series is available, it will be quite satisfactory to use the nearest round figure that can be obtained. It should always be remembered that the tolerance of such resistors is 20 per cent., unless otherwise stated, so that variations up to 20 per cent. either way will have a negligible effect on the performance. For instance, where the circuit says 0.56 meg., an ordinary 0.5 meg. resistor will do equally well. Similarly, 2 meg. will do instead of 2.2 meg., and also for 1.8 meg. The values of the feedback condensers are rather more critical, and can be made up from a number of values in parallel. However, since we are not so much interested in the exact characteristics as in some variations of effect between taps on the switch, it would be quite in order to modify the values a little if difficulty is experienced in obtaining the nominal ones given.

SOME PRECAUTIONS

In adding to the gain of what may already be a high-gain amplifier, it is always advisable to take precautions against hum pick-up, and this applies particularly to a pre-amplifier. It is because of this that a separate heater transformer is shown as part of the circuit, with provision for adjusting the exact D.C. potential of the heater winding with respect to ground, as well as for finding the best spot on the "centre-tapping" resistor for reducing hum to a minimum. The correct way to adjust the two potentiometers is to turn the 5k. pot. so that its moving arm is earthed, and then to adjust the 200-ohm pot. for minimum hum. Then, the 5k. pot. is adjusted independently for minimum hum, and these two potentiometers are left preset.

When attaching it to the main amplifier, it should be remembered that the pre-amplifier has a great deal of gain at very low frequencies, and that the whole system will do its best to motor-boat or oscillate at a frequency of a few cycles per second. If this happens, it does not mean that the pre-amplifier itself is unstable, for it is inherently stable, and will not oscillate on its own. Thus, any motor-boating that is experienced can be cured right away by installing its own separate power supply. However, this is a rather expensive cure, and it should be possible to operate it from the main amplifier as long as adequate decoupling is employed. A filter comprising a 50k. resistor and a large electrolytic condenser of 16 μf. or bigger should enable the unit to be attached to any amplifier which does not motor-boat on its own account. If even this is not successful in eliminating the trouble, steps will have to be taken to clean up the main amplifier itself by inserting some decoupling filters in the early stages. However, a well-designed amplifier should not be so near to low-frequency oscillation as to need extra decoupling, so that little difficulty should be had in practice.

If a long line is to be run from the pre-amplifier to the main amplifier, it will be an advantage to install a cathode follower after the present output terminal. A long shielded lead can then be run between the two units without altering the performance in any way.

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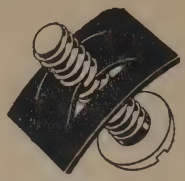

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A Frequency-Compensated Three-Step Attenuator For Use With Oscilloscope Amplifiers

A good deal of trouble is often taken to see that some amplifiers have an excellent frequency response, and the fact that an ordinary volume control potentiometer can cause very bad high-frequency losses is often forgotten. The simple circuit presented here enables attenuation to be made in steps with no sensible effect on the frequency response of the amplifier to which it is connected.

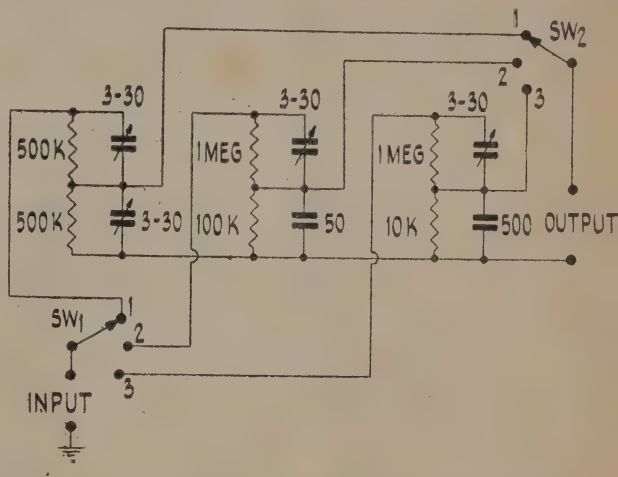
INTRODUCTION

Any amplifier which is used for testing other amplifiers must have better characteristics than the amplifiers which it is to test. This fact is usually realized by the makers of oscilloscopes, who provide amplifiers whose frequency response and distortion are very much better than those normally encountered in audio amplifiers. This becomes necessary in order that falling-off in frequency response, or distortion, both of which may be observed on the screen of the oscilloscope, will not be put down to the amplifier under test when, in fact, they are attributable to the amplifier in the 'scope itself. When the oscilloscope is to be used to examine distorted waveform, such as pulses and square-waves, it is necessary for the 'scope amplifiers to have a very wide response, extending out as far as several megacycles per second if the shapes of the waveforms displayed on the screen are to be a true representation of those being examined. Of course, for ordinary audio work such specialized amplifiers are not necessary, but even here it is desirable for the 'scope amplifiers to have plenty of amplification left as high as 60 to 100 kc/sec., and to be quite "flat" up to at least 20 kc/sec. Fortunately, resistance-capacity coupled amplifiers can easily give us this sort of performance, even when triodes are used, but there is an effect that is very often forgotten, and which may lead to mistaken conclusions if it is not taken into account.

CAPACITIES IN VOLUME-CONTROL POTENTIOMETERS

The effect we refer to is the loss of high-frequency amplification that can be caused by the common or garden volume control. Little or no thought is given to this effect in ordinary audio amplifiers, because in general it is small enough to be ignored until we become interested in frequencies above 10,000 c/sec. Nevertheless, we have observed it ourselves at frequencies as low as 7000 c/sec., and this is far too low to be neglected if the amplifier concerned is to be a high-fidelity one.

The trouble is that by the very nature of its construction, the ordinary carbon potentiometer has considerable capacity to earth—i.e., to its earthed case, from its moving arm, and it is this capacity which causes the trouble. One way to minimize it is to use as low a value for the potentiometer as possible, but this cannot always be done easily, for reasons connected with the rest of the circuit. In audio amplifiers, another way to minimize it is to see that the control is normally used near one end of its travel. The reason for this is that the capacity we have referred to has its most detrimental effect when the slider is at the point of half-resistance. At this point, the capacity finds itself in parallel with the highest resistance—namely, a quarter of the value of the potentiometer, and if it is moved either up or down from this place the resistance in shunt with it becomes less, so that the loss of high frequencies also becomes less. Thus, the frequency response of the amplifier suffers least if the potentiometer is near either maximum or minimum setting. Incidentally, this is one reason for having more amplifier gain than strictly needed, since a low setting of the volume control results.



Note.—There should be an earth sign on the common output line. This was accidentally omitted from the drawing.

In oscilloscope amplifiers, it is highly desirable that any gain control should have as little effect on the frequency response as possible, and if it can be done, it is best for the effect to be non-existent. The problem is quite a difficult one when continuous gain control is needed, but the circuit presented here is a partial solution, which, with the aid of another simple dodge, can be turned into a complete one.

THE COMPENSATED VOLTAGE-DIVIDER

The same difficulty that we have been discussing occurs even when the gain control is done in steps, by switching in a number of fixed voltage dividers, although in this case it can be made less. In addition, when the total resistance of the voltage divider is to be made high, as is desirable at the input of a 'scope amplifier, the problem becomes more pressing. The cure is the arrangement usually known as the compensated voltage-divider. This can be seen, individually, in the three sections of the complete circuit on this page. It depends for its success on the following facts.

In the first place, it is possible to make a voltage divider from condensers, as well as with resistors, and, secondly, a capacitative voltage-divider has no frequency effect whatever. That is to say, its frequency response is flat from the lowest to the highest frequencies, as long as the condensers used

do not exhibit different capacities at different frequencies. However, for our purpose, the latter effect can be ignored, as it does not usually come into play until very high radio frequencies are reached.

Unfortunately, a capacity voltage-divider cannot be used in the grid circuit of a valve, as it provides no D.C. path to ground from the grid. However, this need not defeat us, because it can easily be shown that a composite voltage-divider made up of a resistive divider and a capacitative one in parallel can be so proportioned that the frequency response is still quite flat, up to the highest frequencies. For this to be true, only one simple rule has to be followed: THE RESISTIVE AND CAPACITATIVE VOLTAGE-DIVIDERS, TAKEN SEPARATELY, MUST HAVE THE SAME DEGREE OF VOLTAGE DIVISION. To take a very simple case, suppose that the output voltage is to be exactly one-half the input voltage. Then, the resistors must be equal, and the condensers must also be equal, in which case each one, regarded as a separate unit, divides the voltage by a factor of 2.

A better way of looking at the above statement in capital letters is this: The **reactances** of the condensers must be in the same ratio as the resistors. And since the reactance of a condenser, at a given frequency, is inversely proportional to its capacity, it follows that the ratio of the capacities of the condensers must be the reciprocal of the ratio of the resistance values. For example, in the diagram, the centre voltage divider has a resistance ratio (top resistor to lower resistor) of 10 to 1, so that by applying the rule just formulated, the ratio of the capacities (also top condenser to lower condenser) must be 1 to 10.

Now this is the only stipulation, and it will have been noticed that there is nothing which says what the actual condenser values shall be. Thus, if the voltage-divider is to divide in the ratio of 11 to 1, as in the case just examined, the resistors can have any values as long as one is 10 times the other, and the same thing goes for the condensers.

THE COMPLETE THREE-STEP ATTENUATOR

The circuit diagram shows how three such compensated attenuators can be connected with a switch so that any one can be selected at will. A glance at the resistor values shows that the left-hand one divides the input voltage by 2, the second by 11, and the third by 110. The reason for these rather odd nominal values is that, unless precision resistors are used, there is no object served in specifying the odd values that would have to be used in order to divide by a round 10 or 100 times. Also, the first stage, dividing by 2, has been put in for a special purpose. In this connection it will be noted that there is no "straight through" position. The use of a small attentuation on the first step is a further precaution, taken so that the performance on all positions will be more closely the same, and this would not be the case if a straight-through position were provided.

It will be noted that the top condenser in the case of the two large steps has been made a small variable condenser, while the lower condensers are fixed. This is to enable the circuit to be adjusted experimentally, and so to prevent the necessity of measuring the input capacity of the following valve and of using precision condensers in any part of the circuit.

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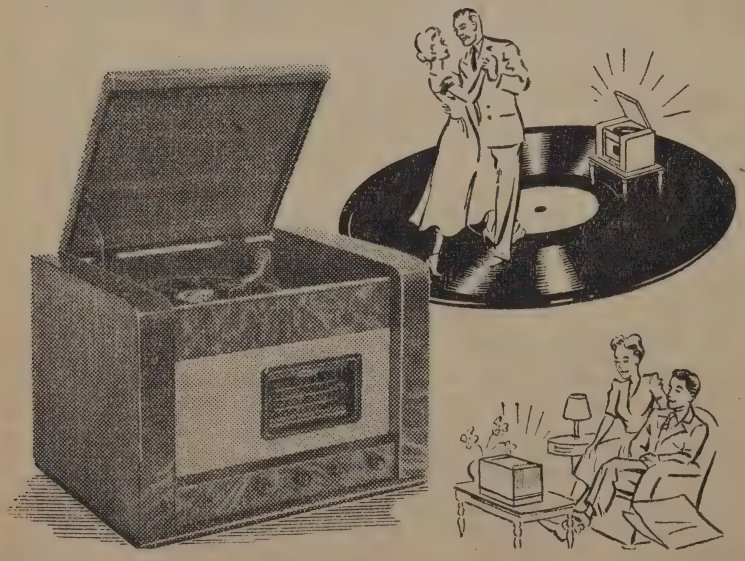

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In an oscilloscope amplifier, it is desirable to have both a high input resistance and a low input capacity, and it is for this reason that the upper condensers in each case have been made as small as conveniently possible. The first valve itself has a certain amount of input capacity, and it might be thought possible to use this as the lower condenser simply by adding the upper one and adjusting it until the right ratio is obtained. If this is done, however, the upper capacity required would be impossibly small, and so in every case the lower capacity is brought up to a value which gives a reasonably large value for the upper capacity, for ease of adjustment, but, at the same time, as low a value as possible in order that the input capacity may be as small as possible.

Remembering the rule above, it will be seen that the middle divider should have a value of 5 $\mu\mu$f. for the upper condenser, and the right hand one a value of 5 $\mu\mu$f. also. Thus, except for a very slight difference made by the addition of the valve's input capacity to the lower condenser, the input capacity in these two positions will be substantially identical. In the case of the left-hand divider, the additional small condenser in the lower position could possibly be omitted, but, if it is included and set for minimum capacity, the top condenser will be easier to adjust.

ADJUSTING THE DIVIDERS

If the attenuator is to be used at the input of a 'scope amplifier, it will be a simple matter to use the C.R.T. itself as an indicator. First of all, it will be necessary to find out how high a frequency the amplifier will handle without any falling-off being observable. As long as this frequency is higher than the flat response of the uncompensated voltage divider, the amplifier may be used, but, if it is not, it will be useless to incorporate a compensated voltage divider anyway! The adjustment procedure is then very simple. A frequency is chosen that is within the audio range and which is so low that the upper condensers can be set to any position without making any noticeable difference to the response. The input level is adjusted to give a convenient deflection on the screen of the C.R.T., and this deflection is noted. Next, a high test frequency is used, such that it is high enough for the uncompensated voltage-divider to cause some falling-off, but not high enough for the falling-off of the amplifier to be noticeable. The same input voltage as before is applied, and the upper condenser is then adjusted until the deflection is the same as was obtained with the low test frequency. When this has been done, the divider is properly adjusted, and checks at other frequencies should show that the response of the divider is now flat over the whole range. The same process is gone through for each voltage-divider, after which the whole attenuator is properly adjusted and the trimmers can be sealed into position.

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AUDIO EQUIPMENT AND DESIGN:

Tunable A-F Amplifier. Circuit and details of a unit which may be used as a general-purpose signal source (audio), variable frequency selective amplifier, or frequency-rejection filter. When used as a selective amplifier, with receiver for code reception, the reception through interference is claimed to give better rejection than a crystal filter. Circuit is based upon phase-inverter connection for driving a half-lattice R-C filter of the all-pass type. Used as an oscillator, the unit provides a source of quadrature voltages to give a circular sweep on C.R.T. Uses two valves of duo-triode type (6SL7) and small number of resistors and capacitors.

—Electronics (U.S.A.), July, 1949, p. 77.

Custom Audio Installations; Part 2. Circuit and construction of a portable home-demonstration high-fidelity system, and suggestions for production and demonstration of high-fidelity amplifiers.—Service (U.S.A.), June, 1949, p. 30.

Audio Filter for eliminating QRM. Description of techniques and equipment for elimination of interference, CW and phone. A composite unit is described which incorporates both CW and phone filters.—QSA (U.S.A.), July, 1949, p. 51.

ANTENNAE AND TRANSMISSION LINES:

A Variable Frequency Antenna. Description of a remotely-controlled, centre-fed antenna capable of continuous adjustment from band to band (amateur), and within each band, using untuned transmission line. Antenna is basically a folded-dipole of adjustable length and has been designed for 11, 10, 6, and 2 mc. bands. Constructional details.

—QST (U.S.A.), July, 1949, p. 41.

CIRCUITS AND CIRCUIT ELEMENTS:

Incremental Phase-shifter. A range simulator circuit which produces two signals of same frequency but differing in phase by fixed and equal amounts. Applications include use as a laboratory phase standard.

—Electronics (U.S.A.), July, 1949, p. 94.

TRANSMISSION AND TRANSMITTERS:

Narrow-band Pulse Transmission. Consideration of possibility of using pulse transmission on amateur communication bands as a means of increasing the number of non-interfering signals per band. Subject to certain safeguards, the joint and simultaneous use of frequencies by CW and phone stations is possible. Details of practical tests. Fundamentals of pulse transmission explained.—QST (U.S.A.), July, 1949, p. 11.

10-Meter Handie-Talkie. Circuit and construction of a self-contained portable transmitter-receiver. Transmitter is crystal controlled (7 mc. crystal), designed for operation on 28 mc. band. Receiver is super-regenerative, using one 3A5 type valve. Transmitter employs two valves of dual-triode type, also 3A5.

—QST (U.S.A.), July, 1949, p. 17.

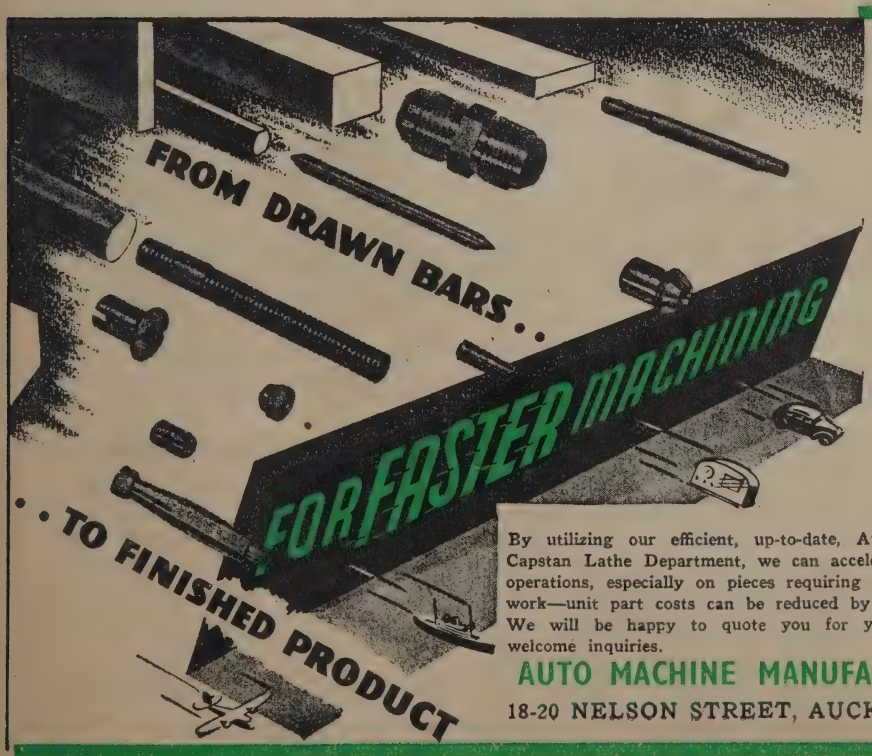
An Inexpensive V.F.O. Transmitter. Circuit and constructional details of a low-powered (20-watt) unit for 3.5 and 7 mc. output. Has 6AG7 valve in a Clapp oscillator circuit, 6V6 buffer-doubler, and 6V6 push-pull doubler output. Designed for break-in keying and has built-in antenna coupler.

—QST (U.S.A.), July, 1949, p. 20.

MEASUREMENTS AND TEST GEAR:

Electronic megohmeter. D.C. measurements of resistance. Method of resistance measurement (up to approximately 10^{10} ohms) with unit the circuit of which depends upon grid-voltage grid-current characteristics of a triode valve. A substitution method of measurement is also described, based upon the high grid-cathode D.C. resistance of a triode when the grid is negative with respect to cathode. A circuit is described for measurement of resistance up to 10^{17} ohms, using an electrometer valve in a slide-back system. Finally, method explained for using Wheatstone Bridge with VTVM to overcome the insensitivity of usual circuit due to low input resistance of indicating instrument compared with the output resistance of the bridge.

—Wireless World (Eng.), October, 1948, p. 354.



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Surveillance radar deficiencies and how they can be overcome. Investigations being made in U.S.A. to determine the possibility of integrating ground surveillance, or primary, radar with present air-traffic control systems. Article describes limitations of primary radar and considers methods for overcoming such limitations in order that maximum use may be made of radar systems. Conclusion reached that "with the aid of co-operating airborne transponders, secondary radar, backed up by primary radar, can become a primary aid in traffic control."

—Proc.I.R.E. (U.S.A.), August, 1948, p. 1015.

Transductor fundamentals. Comprehensive analysis based on voltage oscillograms. Investigation of variations of flux and transductor applications outlined, with circuits.

—Electronics (U.S.A.), September, 1948, p. 88.

Dry-cleaning electronic equipment. Description of a method, used at a U.S. airline base, for radio overhaul. Compressed air used to spray equipment with a cleaning solvent.

—Electronics (U.S.A.), September, 1948, p. 94.

Digital computer switching circuits. Details of basic operational requirements and means of obtaining them. Reference to special requirements of switching systems.

—Electronics (U.S.A.), September, 1948, p. 110.

Modern Breadboard Chassis. Description of a method developed for wiring of experimental circuits. Employs special chassis with socket holes punched; has bus-bars, spring contacts, and flexible leads for quick and reliable connections.

—Electronics (U.S.A.), July, 1949, p. 101.

Design and Construction of a Custom Cabinet. Constructional details of a cabinet of modern design which houses a receiver and an automatic record changer. Has bookcase front and is made of ¾ in. plywood.—Service (U.S.A.), June, 1949, p. 32.

Coin-operated Automatic Phono Servicing. Details of special circuits used in three types of American "juke box" amplifiers. Servicing hints.—Service (U.S.A.), June, 1949, p. 10.

Radio Telemetering. Consideration of factors influencing choice of system to be used when specifications to be drawn for a radio telemetering system required for a particular purpose. Reference to (1) types in current use; (2) choice of system and method of modulation; (3) choice of carrier radio frequency; (4) choice of commutation method for time multiplexing; and (5) general summary.

—Electronic Engineering (Eng.), June, 1949, p. 209.

The Radio Research Board (Eng.). A summary of the functions of R.R.B., more particularly in relation to the Department of Scientific and Industrial Research. Editorial.

—Wireless Engineer (Eng.), May, 1949, p. 145.

Balanced Two-wire Method of Reducing Ignition Interference. Claimed to be superior to methods using shielding or suppressors; two-wire method calls for ignition plugs with two insulated electrodes, a distributor with two arms and a centre-tapped high voltage winding. Wiring system is symmetrical and radiation is thereby kept low.

—Communications (U.S.A.), May, 1949, p. 22.

Rectifier Voltage Control. Use of saturable-core reactors, their action described, and features in design outlined.

—Wireless World (Eng.), June, 1949, p. 227.

MISCELLANEOUS:

Ultrafax. Brief details of equipment and methods used in demonstration, in Washington, U.S.A., in October, 1948, of new system of ultra-high-speed transmission of intelligence in printed form by use of a combination of facsimile television and photography.—Electronics (U.S.A.), January, 1949, p. 77.

Darkroom Timer. Circuit and details of small, simple timer which may be adapted to any photographic enlarger. Multiplier phototube used as scanner with specially designed voltage stabilizer.—Electronics (U.S.A.), January, 1949, p. 101.

There's Money in Custom Installations. Part 2. Further details of "custom"-built units and their proper location.

—Radio News (U.S.A.), February, 1949, p. 56.

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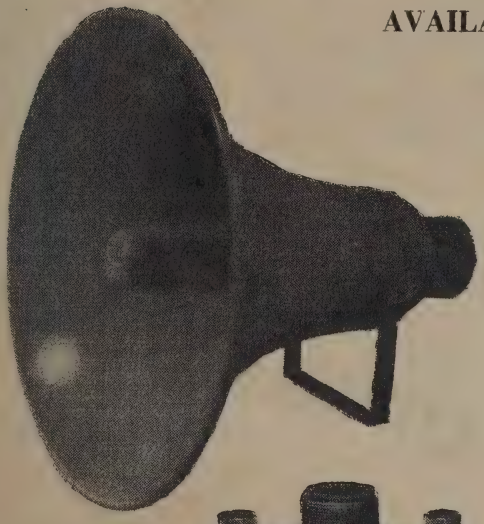

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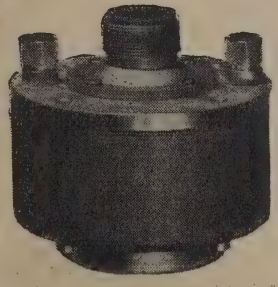

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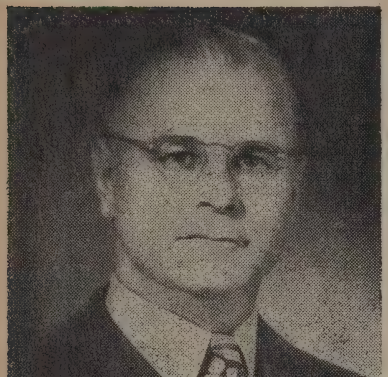

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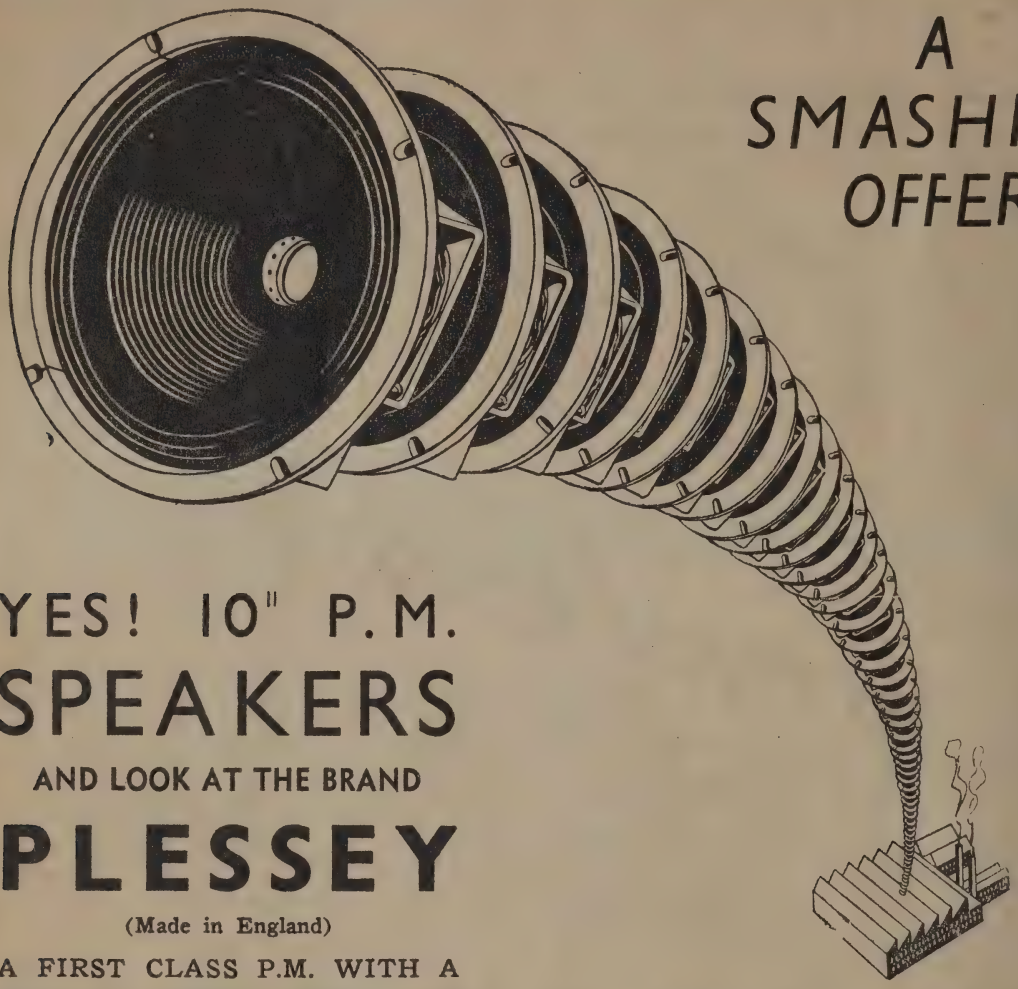

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INTRODUCTION

It has been stated before that the 807 is not a very suitable valve for working as a triode in Class B, but an entirely new idea has been put into practice by A. M. Seybold, of R.C.A., and this was originally described in "Ham Tips," published by that organization. This new method of using 807's appears so promising that we are making haste to publish the details, as we have them at present from this authoritative source. We ourselves have done no confirmatory experimental work along the lines suggested, but hope to in the near future, because there are several things which appear to be left unsaid in the original article and which will undoubtedly be of interest to amateurs here. Since these useful tubes are still available at give-away prices, there will be many who should look with favour on a circuit which enables them to be used, to get all the audio power that can legitimately be used.

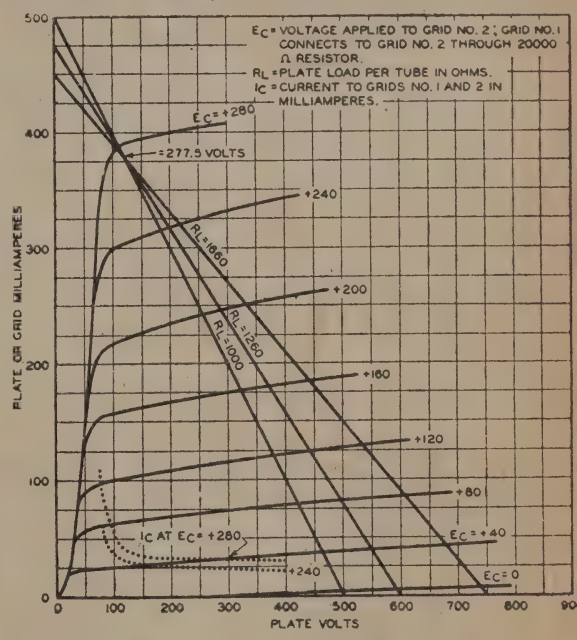
PURPOSE OF THE NEW IDEA

The development of the circuit we are about to present was undertaken because it was felt that the possibilities of the 807 as a high-powered audio amplifier were rather being overlooked by amateurs. This was felt to be due to certain difficulties associated with using them as Class AB_2 tetrodes.

When worked in this way, it is essential, if full power output is actually to be obtained, for both screen and grid voltages to be very well regulated. In view of this, and because one of the most attractive features of the zero-bias Class B triode type of power amplifier is the fact that it has no bias or screen supply whose regulation has to be worried about anyway, it was decided to see if there was not some way in which the 807 could be used, triode connected, in Class B, and with zero bias.

The obvious first choice of connections was to connect screen and control-grid together, giving a high-mu triode. This has been done by a number of workers, but not with very much success, because, although a high-mu triode certainly results, its characteristics are not very well suited to the object in view. The main reason for this lies in the fact that the "knee" of the Ip-Ep curves occur at too high a voltage, thus preventing a very high plate voltage swing and limiting the power output to a uselessly small figure. Another arrangement that was tried was to earth the control grids and to use the screens as control grids. This arrangement gave a good series of plate curves, but the signal voltage on the "grids" was much too high.

The final arrangement is shown in the circuit diagram. The input is applied to the screens and control grids simultaneously, but the elements are not directly connected together. Instead, they are connected through a 20,000-ohm resistor. This has two effects: The first is to keep the knee of the plate curves down to approximately 100 volts and the second is that, by applying some of the input voltage to the control grids, the signal voltage needed for full output is not so high as when the grids are earthed. Even so, the voltage required is high enough, but it is not so high that it cannot be obtained quite readily by means of transformer coupling.



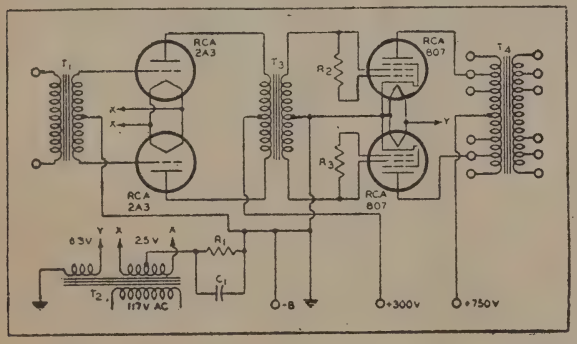
The 807 plate family with a 20,000-ohm resistor in the No. 1 grid circuit.

DIFFERENCES BETWEEN THE PRESENT ARRANGEMENT AND THE MORE USUAL ZERO-BIAS CLASS B TUBES

The only essential difference between the present arrangement for 807's and other valves that are used as zero-bias Class B stages is that the latter require step-down transformers from the driver valves because the impedance of the grid circuit is very low. Here, however, the grid-voltage/grid-current characteristics are quite different, in that, although grid current is drawn at all times during the positive half-cycle of the driving stage, the grid circuit impedance is high instead of low. The practical effect of this is that, whereas the normal Class B valve needs the exciting voltage to be low and the grid current high, the 807's need a high exciting voltage and a relatively

low grid current. The original article by Seybold gives the grid input impedance of each 807, with 750 volts on the plate as 7100 ohms. This means that, if the driver stage consisted of, say, a pair of 2A3's, requiring a plate-to-plate load impedance of 5000 ohms, an impedance step-up from the total driver transformer primary to one-half of the secondary would be $7100/5000 = 1$ to 1.4. This necessitates a turns ratio of 1 to 1.2, primary to half secondary. Unfortunately, this is not a standard sort of driver transformer, but it would not be a difficult one to have made up by any firm which specializes in transformer design and manufacture.

With a plate voltage of 750, the driving power required is of the order of 5.3 watts. This is well within the capabilities of a pair of small power triodes, such as 2A3's, or even 45's, as long as it is remembered that there should be about 20 per cent. extra power available to take care of losses in the driver transformer.



Schematic for driver and output stages used in the tests.

OPERATION AT OTHER PLATE VOLTAGES

Among the limitations of the original article upon which this one is based is the fact that the data are incomplete, even for the 750-volt operating condition, which is the only one described in any detail. For instance, it is not stated what order of plate current swing is obtained from the 807's. This is important when it comes to designing the power supply, especially in view of the fact that if the regulation of the H.T. voltage is not good enough, the full theoretical power output will not be obtained.

Other information which readers will no doubt require is that concerning the available power output of the circuit at plate voltages less than 750. This again was not stated in the original article; and it is along these lines that we hope to obtain some experimental data for presentation in these pages at a later date. However, a certain amount of information is contained in the valve curves that were given, and which we have reproduced here. Three load lines are drawn, and show that for lower plate voltages than 750, the correct load line is one drawn from the actual plate voltage on the horizontal scale to the knee of the curve for a grid voltage of plus 280. It should be remembered in examining this figure that the curves are for one valve only, so that the load lines as drawn refer to EACH TUBE and not to the plate-to-plate load impedance. However, this is easily got from the figure by remembering that in a push-pull stage, the plate-to-plate load impedance is **four times** the load for one valve. For instance, the load line that is shown for the 750-volt condition is 1660 ohms for one valve, which gives us a value of $4 \times 1660 = 6640$ ohms plate-to-plate.

From the other load lines, which are drawn for plate voltages of 600 and 500 volts respectively, we obtain the information that for 600 volts on the plates, a plate-to-plate load impedance of 5040 ohms is needed, while with 500 volts on the plates, the required plate-to-plate load impedance is 4000 ohms. Since these load lines all cross at the knee of the plus 280 volts curve, it can be inferred that for lower voltage operation the grid voltage required is the same as for the 750-volt condition—namely, 277.5 volts peak per grid. Thus, although the driving powers for lower plate voltages are undoubtedly different from the figure already quoted for 750 volts, it can also be inferred that the driver transformer

(Continued on page 48.)

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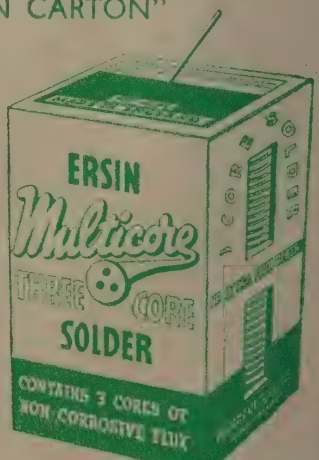

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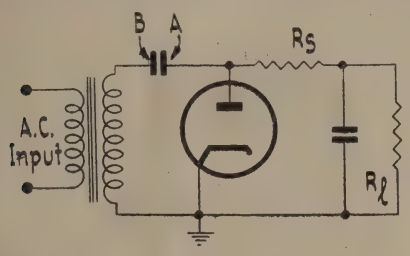
QUESTIONS AND ANSWERS

HOW AN ORDINARY SHUNT RECTIFIER WORKS

"G.S.McN.," Whangarei, writes with a question that is more fundamental than most which find their way into this column, and which, although apparently of an elementary nature, is one which stumps many people, as our correspondent has discovered. He has built the condenser tester that was featured in our first issue, that of April, 1946. The basic circuit of this tester is a simple shunt rectifier, as shown below, and there are a number of points about its operation that our correspondent would like elucidated. Incidentally, he has put these questions to a



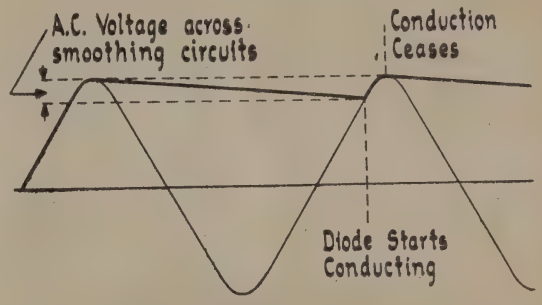
large number of people who have a working knowledge of radio matters, including a meeting of amateur transmitters at his local N.Z.A.R.T. branch, without obtaining what he considers a satisfactory explanation. We do not know whether our explanation will satisfy him any better, but we hope so, and also that in so doing, the fundamental understanding of a simple but basic circuit by a number of our readers may be bettered. One of G.S.McN.'s difficulties is that he cannot see that the full A.C. input voltage, as well as the rectified D.C. voltage, is not applied to the filter network. The point, as he remarks, is an important one, since, if he is correct, then such a circuit is no place to use an electrolytic condenser! Now for the explanation!

The writer believes that a good deal of the difficulty that is often encountered in understanding the action of this circuit is due to a confusion between the A.C. and D.C. relationships of the circuit. For example, our correspondent asks what happens to the negative half-cycles of the applied A.C. voltage, and whether or not they must be conducted or bypassed to the ground.

Suppose we examine the circuit at the moment of switching on. If the first cycle is to be applied to the diode through the condenser is a negative one, **a negative potential, varying in value over the half-cycle, is applied to the plate of the diode, but, since the latter cannot conduct in this direction, no current flows.** If the first half-cycle is a positive one, then current flows through the diode. In the conventional sense, this current flows from the plate to the cathode, but, in fact, electrons flow in the circuit in the direction shown. The flow of electrons results in the plate A of the condenser acquiring an excess of electrons, as compared with its uncharged state, so that it becomes negatively charged **from the D.C. point of view.** Some people have difficulty at this point in seeing how, with A.C. applied to the plate B of the condenser, it can be changed in the D.C. sense at all. This is easily explained, however, because, although the A.C. is still applied to the plate B of the condenser, it can be charged in the this plate is zero, because the A.C. excursions in the positive and negative directions are equal and, over the period of one cycle, cancel each other.

Now, since the resistance of the diode when conducting is very small, we can consider that on the positive half-cycle of the applied A.C., while the diode is conducting, the condenser charges up instantaneously, so that, after the first positive half-cycle has passed its peak value, the condenser is negatively charged to the full peak voltage of the applied A.C.

Let us imagine for a moment that there is no load on the rectifier, so that, in other words, no current



is drawn from the circuit. In this case, after the condenser has charged up to the peak A.C. voltage, it cannot become discharged, because this would mean that the diode would have to conduct in the reverse direction, which it cannot do. Thus, when the next positive half-cycle of the A.C. comes along, there is effectively a negative bias on the diode plate equal to the peak A.C. voltage, and it is not possible for the diode plate to become more positive than the cathode, and no further conduction takes place.

However, in practice, there is a load on the diode, in this case consisting of the smoothing resistor Rs and the load resistor Rl in series. Thus, **after** the condenser has charged up to peak A.C. voltage, it starts to discharge through the smoothing and load circuit. The rate at which this discharge takes place will be determined by the size of the condenser, and the values of the resistors. If the load resistance is small, the charge will mostly leak away before the next positive half-cycle of the A.C. voltage comes along, but if the load resistance is high, only a small

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portion of the charge will leak away. Let us suppose, then, that when the next positive half-cycle arrives, the charge **left on the condenser** is 90 per cent. of the peak A.C. voltage, to which it was originally charged. If this is the case, the diode will not conduct again until the next positive half-cycle reaches 90 per cent. of peak voltage. It will then start to conduct, and will do so until peak voltage is reached, when conduction ceases once more. From the above, it can be seen that, with no load at all, the D.C. output voltage will be equal to the peak A.C. voltage, and will be lower the greater the current drawn by the load. There is no question of what happens to the negative half-cycle of the A.C. wave, as there is just no path through the diode for it and it remains a potential which delivers no current because the circuit is open. One might as well ask what happens to the voltage of a battery when there is nothing connected to its terminals. The answer is "nothing."

Although the circuit appears rather different, the action of the shunt diode rectifier circuit is actually similar to that of the better-known series rectifier circuit. The only real difference is the point in the circuit at which the condenser is attached. In the series circuit, it is in the D.C. side of the circuit, but here it is in the A.C. side, which, as explained above, makes no difference to the D.C. relationships, since plate B of the condenser is at an average potential of zero volts.

The voltage applied to the smoothing circuit can-

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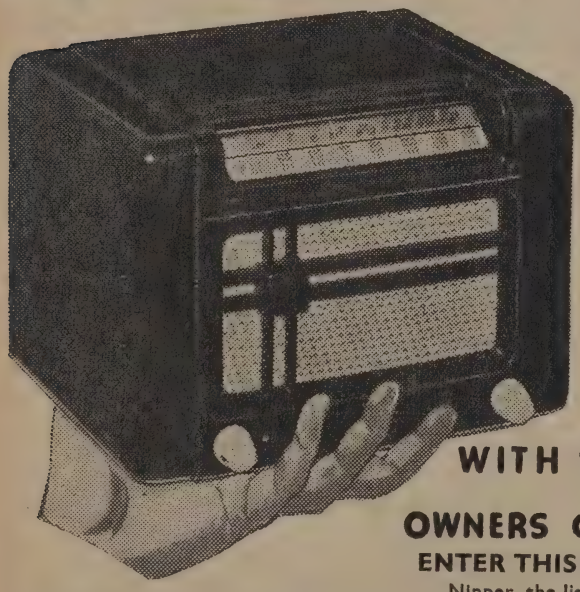

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not be higher than the peak A.C. voltage, and in the case where there is no load at all, is a pure D.C. voltage, with no A.C. component at all. When a load is applied, there is a small A.C. component of peak voltage equal to one-half the **difference** between the peak A.C. voltage from the transformer and the voltage to which the diode starts to conduct. As can be seen from the figure, this A.C. component will be greater the greater the load current, and thus the greater the drop in condenser voltage before the next positive half-cycle catches up with the voltage remaining on the condenser. Under no circumstances can there be the full A.C. voltage applied to the smoothing circuit in addition to a large D.C. voltage. In all practical circumstances, the A.C. voltage appearing across the smoothing circuit is only a small fraction of the D.C. voltage, so that the condensers are at all times correctly polarized, and electrolytics are able to cope quite well here, as in other rectifier circuits.

THE "NEW HIGH-QUALITY AUDIO AMPLIFIER" AGAIN

"G.L.B.," Dunedin, writes to point out that in the above amplifier, which uses push-pull triode-connected EL37's in the output stage, we have recommended the use of an output transformer to match 6600 ohms to the voice-coil of the speaker, whereas the valve manufacturers state that the plate-to-plate load impedance should be 4000 ohms. He asks whether there is any reason for the change and if we would confirm that our figure is correct.

The answer is that our figure of 6600 ohms was intentional, and, further, that we were aware of the difference between this and the valve data book's recommendation. The fact is that triodes are not critical as to load resistance to nearly the same extent as pentodes or beam tetrodes, and that in practice there is a good deal of leeway. In fact, there are definite advantages in using a higher load impedance than that usually recommended. These things are always compromises in one way or another, and the point in connection with the recommendation of load impedances is one in the following way.

Lower values than the ones recommended in the valve books can be used where power output is of more importance than distortion, since the latter increases, along with the power output, as the load impedance is lowered from a particular value (usually twice the plate resistance of the valve, for a single-ended stage). On the other hand, increasing the load impedance decreases the distortion, but at the same time lowers the maximum available power output. Thus it can be seen that the choice of a load impedance in a given case is a matter for compromise between maximum power output, on the one hand, and minimum distortion on the other. The value usually recommended by the manufacturers is most often one of a general-purpose nature, which can be varied within quite wide limits according to requirements at the moment. Since in the above amplifier distortion was to be reckoned the most important factor, and the gaining of an extra watt or two of power output, relatively unimportant, we decided to use a higher load impedance than the general-purpose one given in the book. Also, in this case, it is handy because there are a number of

(Continued on page 48.)

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1. General Description:

This is a 5 valve battery broadcast receiver designed to provide the maximum battery economy consistent with reasonable sensitivity and power output. The current drain of this receiver, with the dial lamp switched off is .9 amps.

In certain cases, however, greater sensitivity and power output may be required, and if the greater battery drain can be tolerated, this may be achieved by the bridging of the 2.4 ohm resistor which will be found in series with the input line to the vibrator transformer primary. If this is done the current drain will increase to 1.4 amps. Voltage tests are given below for both methods of operation.

The valve filaments are connected in a series-parallel arrangement so that filament drain may be kept at a minimum. It is important, however, that no valve (with the exception of the 1J6) be removed from its socket while the set is on.

The following valve types are used:

1C7 Frequency Converter

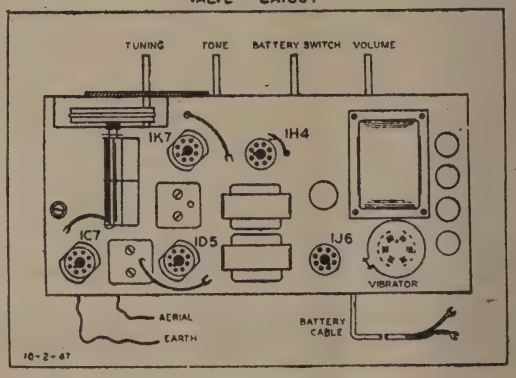
1D5 I.F. Amplifier

1K7 2nd Detector, A.V.C., & Audio

1H4 Audio Driver

1J6 Class "B" Output.

MODEL 42
VALVE LAYOUT



2. Alignment Procedure:

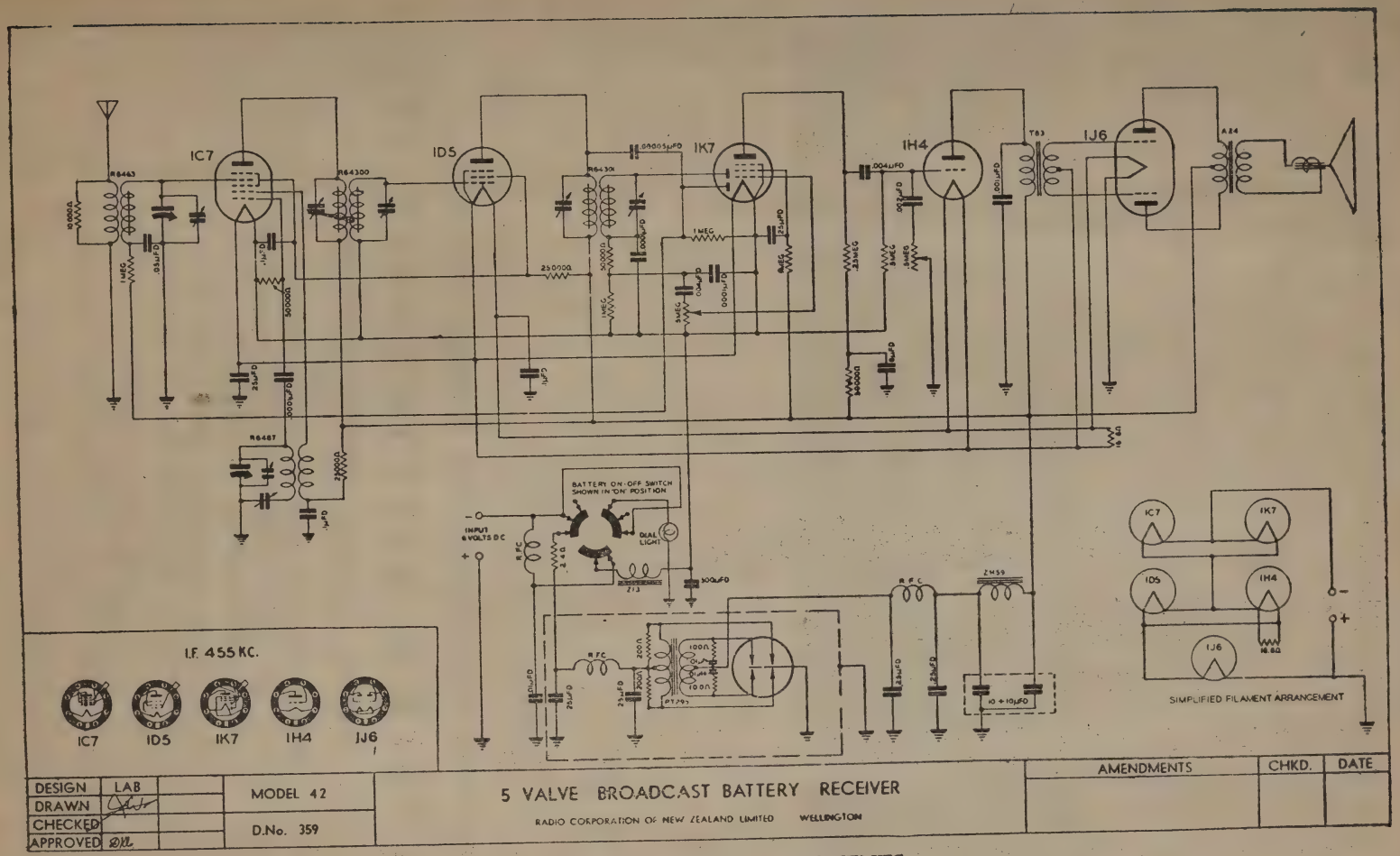
This is fully covered in Service Bulletin No 72 "Standard Line-up Procedure for Multi-Band Receivers," a copy of which is obtainable on application to the Engineering Department. The intermediate frequency is 455 Kc., and line-up points are 1400 and 600 Kc.

3. Voltage Tests:

'A' with 2.4 ohm resistance in circuit and 'B' with the 2.4 ohm resistance shorted out.

	A.	B.
First 10 mfd electrolytic condenser	94v.	130v.
Second 10 mfd electrolytic condenser	93v.	128v.
Screens of 1C7 and 1D5	35v.	50v.
Screen of 1K7	8v.	10v.
Plate of 1K7	10v.	20v.
Oscillator plate of 1C7	50v.	75v.
Across each valve filament	2v.	2v.
Grid of 1J6 with respect to chassis	−3.5v.	−3.5v.
Grid of 1H4 with respect to chassis	−.6v.	−.6v.
Grid of 1K7 with respect to chassis (with volume control off)	−6v.	−6v.
Grid of 1C7 with respect to chassis	−2.1v.	−2.1v.
Grid of 1D5 with respect to chassis	−6v.	−6v.

All the above measurements should be made with the receiver tuned to aproximately 1000 Kc. and with no signal input. The meter used should have a sensitivity of 1000 ohms/volt.



NOTES ON MAIN COMPONENTS

Vibrator Transformer: PT295
Class B Input Transformer: T83
Output Transformer: A24
Chokes: H.T.—ZN59
L.T.—Z13

Tuning Gang: 2 Gang Plessey K.1852/22
Dial Light: 1 only 6.3v. .25a Min. screw base
Dial Scale: O.E.32
Battery Switch: 3.Q.C.D.

NEW ZEALAND RADIO MANUFACTURERS' FEDERATION NOTES

MANUFACTURERS AND N.Z.B.S. OFFICIALS CONFER

With many matters of mutual interest for discussion, executive members of the New Zealand Radio Manufacturers' Federation recently conferred with the Director of Broadcasting (Mr. W. Yates) and the chief engineer, N.Z.B.S. (Mr. W. L. Harrison).

In replying to an expression of congratulation on his appointment, Mr. Yates expressed the opinion that, in the interests of the listening public as a whole, manufacturers and the Broadcasting Service would need to move forward in full co-operation, and must keep in step with each other in all future developments affecting both organizations.

MR. R. SLADE APPOINTED PUBLICITY OFFICER

Realizing the necessity for regular publicity releases from an authoritative source, the executive of the New Zealand Radio Manufacturers' Federation has appointed Mr. Ralph Slade, of Wellington, Federation publicity liaison officer.

"Such a spate of ill-informed publicity emanating from persons with little or no qualification finds its way into the daily Press that regular, representative, and authentic statements are necessary if the public is to receive the true views and picture of the Dominion's radio and electrical industry," said Federation President, Mr. William J. Blackwell, in announcing the appointment. "The Federation is indeed fortunate that Mr. Slade, with his vast knowledge of the industry, has so generously undertaken the appointment."

Left to Right: Messrs. R. Slade, D. T. Clifton-Lewis, T. J. F. Spencer, P. C. Collier (Vice-President), W. Yates (Director of Broadcasting), William J. Blackwell (President), W. L. Harrison (Chief Engineer, N.Z.B.S.), W. I. Cunninghame, and D. A. Clarke (Group Secretary).

NAPIER FOR ANNUAL CONFERENCE

Radio manufacturers this year will meet in Napier for their annual conference from 7th to 9th December, inclusive. Last year's first out-of-Wellington national gathering at Rotorua proved an unqualified success. It is anticipated that, in addition to the many matters of moment to be discussed, Hawke's Bay's reputed sunny clime will attract a record number of delegates.

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Annual Meeting of the Auckland Radio Traders' Association

How to turn an annual general meeting into a pleasant gathering was demonstrated by the Auckland Provincial Radio Traders' Association last month. Held in the pleasantly modern rooms of the National Party Centre, the meeting covered the business of the evening at a smart clip (which showed good staff work by retiring Secretary Peter Buddle and Chairman Sam Mandeno) and adjourned for a tasty supper in the refreshment room and then settled down to hear a most interesting address by Mr. Harrison, chief engineer of the New Zealand Broadcasting Service.

Discussion covered the following ground: Moving the adoption of the report and accounts, the chairman expressed the need for increased membership of traders' associations. Traders who received benefits from associations and turned to them for help when faced with problems should support the association actively throughout the year.

Mr. Christie's few words on the importance to the industry of apprenticeship committees showed how some men have the power to enjoy tasks that others are inclined to steer clear of. This committee is doing a great service for the industry as a whole.

That the association is publicity-conscious was demonstrated by the interest taken in the proposed membership badge and in the discussion on publicity campaigns. The Manufacturers' Federation's advertising campaign last year, although it did not cost the dealers anything, was a great stimulus for business, and several members voiced the opinion that the association should support further such drives. The chairman pointed out that to do this a levy would have to be imposed on dealers, and the meeting then resolved that an approach be made to the manufacturers to institute another campaign, this time in conjunction with the dealers, before the end of this year.

Other subjects covered were North Island Radio Workers' Award, price control, and import licensing.

Election of Officers

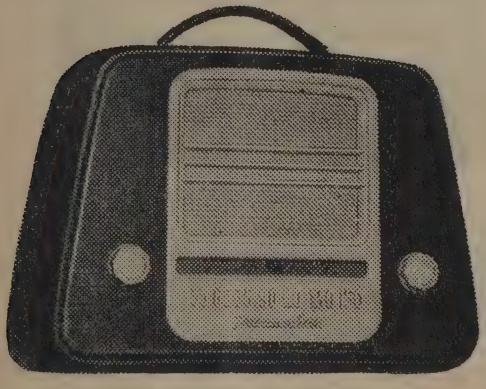
The following officers were elected for the ensuing year: President, Mr. H. J. Barr (Wingate & Co., Ltd.); vice-presidents: Messrs. J. D. Reid (Swan Electric Co., Ltd.) and S. B. Christie (Atomic Radio Ltd.); executive committee: Messrs. W. E. Hunter (Johns Ltd.), D. T. Clifton-Lewis (Radio (1936) Ltd.), F. I. Miller (Miller's Radio, Te Awamutu), and, ex officio, S. D. Mandeno (Mandeno & Co., Ltd.); representative on council of Chamber of Commerce, Mr. S. B. Christie; member of Apprenticeship Committee, Mr. S. B. Christie; member of Seddon Memorial Technical College Advisory Committee, Mr. J. Orbell; member of Seddon Memorial Technical College Electing Committee, Mr. H. J. Barr; auditors, Messrs. Chambers, Worth & Chambers.

The resignation of Mr. P. Buddle was received with regret, and tributes were paid to the work he had done for the association. Mr. J. E. Beachen was appointed in his place. A hearty vote of thanks was also accorded the retiring president for his valuable work in the association's interests.

Mr. Harrison, in his address, gave an insight on the scenes behind the scenes at international conferences, and dealt particularly with the work of the International High-frequency Conference recently

(Continued on page 48.)

SELL IT WITH CONFIDENCE . . .



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THE NEW ZEALAND ELECTRONICS INSTITUTE (INC.) NEWSLETTER

Council News

The new council to administer the institute's affairs during the forthcoming session held its initial meeting recently, when the following elections were received.

Combined Branches: Mr. P. C. Collier, 66 Ghuznee Street, Wellington; Mr. W. L. Harrison, chief engineer, New Zealand Broadcasting Service, 38 The Terrace, Wellington.

Wellington: Squadron Leader J. W. Todd, c/o Director of Signals, Air Department, Wellington; Mr. K. B. Gilby, c/o Transmitting Station, Titahi Bay.

Auckland: Mr. D. P. Joseph, Industrial Electronics Ltd., Box IW, Auckland; Mr. L. O. Hunter, c/o Mr. K. Keith, 177 Queen Street, Northcote, Auckland.

Christchurch: Mr. T. R. Pollard, Director C.C.. I.D.D., Canterbury College; Mr. J. Gregory, c/o Physics Department, Canterbury University College, Christchurch.

Dunedin: Mr. W. L. Shiel, P.O. Box 776, Dunedin; Mr. H. F. Symonds, c/o Physics Department, University of Otago, Dunedin.

Executive Officers

Squadron Leader J. W. Todd was declared elected to the office of president, and Mr. D. P. Joseph, of Auckland, was elected vice-president.

Mr. L. W. Hurrell was reappointed institute treasurer, and Mr. J. H. McIvor, institute secretary.

Gradings

The recommendations of the Admissions Committee regarding the undermentioned gradings were approved and the applicants detailed hereunder were admitted accordingly:

Members: Messrs. P. C. Collier, W. D. Foster, R. Slade.

Associate Member: Mr. D. P. Joseph.

Associates: Messrs. M. Corlett and D. P. Senior.

Student: Mr. B. C. A. Pryce.

Financial Assistance

The treasurer reported the receipt of donations from organizations associated with the electronic industry, and the president expressed the hope that other firms who had not yet indicated their practical support of the institute's objectives would follow the geenrous example of those who had donated.

Examinations

It was agreed that the next examinations of the institute be conducted in March, 1950, and intending candidates should therefore communicate with their local committees prior to January, 1950.

A NEW AND **SAFE VACUUM** SWITCHING DEVICE

THE SUNVIC TIME-DELAY SWITCH is a small, glass-sealed, bimetallic relay, the bimetal being fitted with a small heater winding which, when energized, will close the contacts after a delay of 25 to 100 secs. The switch is evacuated, thereby eliminating any trouble due to oxidization of the contacts, and the totally sealed construction completely excludes moisture, dust, and other foreign matter.

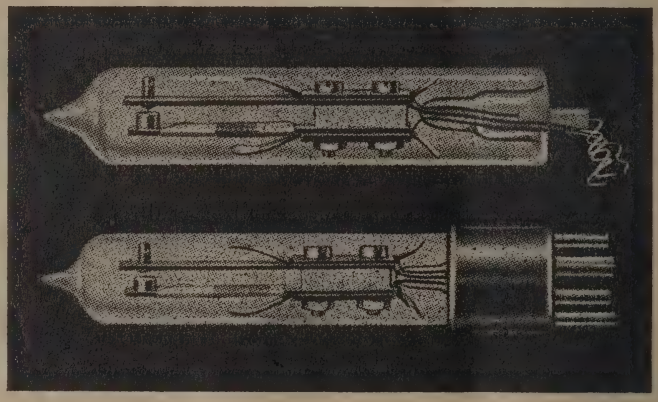
GENERAL SPECIFICATION:

CONTACT RATING: The contacts will carry a maximum current of 1 amp. at up to 380 volts A.C., but will close on a voltage of 600 D.C.

HEATER WINDING: The heater winding is arranged to operate from a 6.3-volt supply, watts dissipated being 2.

TIME DELAYS: Available in selected times varying from 25-100 secs., after energizing heater.

This unit will interest all audio and radio constructors where existing 6.3v. supplies can be utilized to facilitate all H.T. (or modulator load switching).



Actual size of switch

Other Sunvic electronic equipment available includes Electronic Relay, Hot Wire Vacuum Switch Tubes and Units, Energy Regulators, Adjustable Bimetal Thermostats, Adjustable Time Delay Switches (obtainable for various voltages).

Your inquiries will be welcomed. ***Write, call, or phone***

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The "R. & E." Digest of Circuits is something that no radio man, whether serviceman, "ham," or home-constructor, should be without. It will be found a most useful book of reference for those who have taken "Radio and Electronics" since its inception, and will be a very pleasant surprise to our newer readers, giving as it does the essential information on all practical circuits that have been published in this journal up to and including the December 1948 issue.

VARIED SUBJECT MATTER

Circuits will be found in the "Digest" for everything from the simplest crystal sets to eight or ten valve receivers, oscilloscope circuits, audio amplifiers of varying costs and complexities, and circuits of special interest to amateur transmitters.

ORDER YOUR COPY from the bookseller or radio dealer who supplies you with your copy of "Radio and Electronics," or, if you have no such dealer handy, from "Radio and Electronics" (N.Z.) Ltd., Box 22, Govt. Bldgs. P.O. Wellington.

PUBLICATIONS RECEIVED

"Essentials of Radio," by Slurzberg and Osterheld. Publishers: McGraw, Hill Book Company, Inc.

In the main, there seem to be two distinct types of text on radio and electronics. The first is the one which commences without much preliminary matter to treat the subject from the advanced point of view, and retains its high level throughout, making free use of higher mathematics to prove its points. It is rigorously scientific in its approach, and, as a rule, makes no attempt to cater for those of limited attainments in pure physics and mathematics. It is, in fact, directed at those whose accomplishments in these directions are far from negligible. Such texts are authoritative, and fill an important place in the literature of the subject. They can be said to be written for the man with good general training in the physical sciences, or in electrical engineering as a whole, and are the means whereby such men may, in the least possible time, gain an excellent theoretical knowledge in this one specialized branch of electrical engineering, or of applied physics, depending upon the reader's viewpoint. Advanced students have neither the need nor the desire to wade through quantities of elementary A.C. theory, and the advanced text fulfils their requirements.

On the other hand, we have the "popular" kind of text, which eschews mathematics altogether, and which can give only a very elementary idea of the subject by means of analogies (which can never be very well sustained) and qualitative descriptions only. There is undobutedly a demand for such text-books, and many excellent examples exist.

"Essentials of Radio" falls into neither of these categories, and represents that rare class, the "intermediate" text. In it, no attempt is made to do without mathematics, and yet the authors have managed to do without all but elementary algebra and trigonometry, while presenting a large number of the formulae necessary for radio calculations.

The text is well and profusely illustrated with performance curves and illustrations of commercial pieces of equipment, as well as with the necessary circuit diagrams. Liberal use is made of valve curves in those portions of the book which deal with the different types of valve operation. This is an excellent feature of the presentation, and one which is too often neglected in more advanced works. The authors have recognized the value of valve curves in illustrating qualitatively the behaviour of valves, and have used them to the fullest advantage, considering the nature of the presentation.

In an attempt to make the book self-sufficient to as great an extent as possible, the authors have added a number of useful appendices, containing much valuable reference material. There is a large number of sample examination questions and numerical problems after each chapter, as well as a quite comprehensive bibliography.

When you sell a radio set, remind your customer that the better the set the greater the need for a first-class anti-interference aerial. The "EXSTAT" Aerial is designed to cut out the annoyance of electrical interference and to ensure crystal-clear reception at the receiver.

"EXSTAT" has a proven record of service in town and country, and is an ESSENTIAL FITTING for all showrooms.

The "EXSTAT" Aerial

EXSTAT Model ASA 112 comprises 15 ft. vertical rod with lashing mounting, two transformers, and 60 ft. screened cable.

Retail Price, £8 18s. 6d.

Model ASA 100, as above, less rod and mountings.

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Russell Import Co. Ltd.

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420 MC/SEC. TRANSMITTER-RECEIVER

(Continued from page 10.)

When the circuit of a transceiver is switched from transmit to receive, there is one effect that is undesirable, although it is usually slight in itself. We refer to the small change in oscillation frequency that happens on account of the change in the grid leak resistance from the low transmitting value to the high receiving value. When two similar stations are working, this frequency change causes the one which has just switched to "receive" to need to re-tune his receiver slightly. He then switches over to "transmit" after the over is finished, with the result that his transmitting frequency has altered slightly as a direct result of having had to adjust the receiver. In turn, then, the other end has to re-tune its receiver, and so on, until the two transceivers finish up by chasing each other right off the band! How annoying this feature of the transceiver can be can only be realized by someone who has worked with a pair of similar ones and has actually experienced it.

In order to obviate this difficulty, we have used separate R.F. circuits for transmitter and receiver, and have gone even farther, by making the receiver continuously tunable over the band, but **leaving the transmitter on a spot frequency.** In case some readers might think that it is a disadvantage not to be able to tune the transmitter except with a soldering iron (which is actually the case), we would like to point out that we are no worse off than the man on the lower frequency bands who is crystal controlled and has only one crystal. In both cases, he is unfortunate if some interference crops up on his transmitting frequency, but on 420 it is not very likely that such will occur. Even we are not so optimistic as to suppose that immediately after this issue is published 420 will become a mass of signals in any one place. With the fixed tuned transmitter, it was particularly noticeable that the receiver stayed put on the same dial setting even when the signal had become so weak as to be hardly tunable. In fact, one could tune the signal in while it was strong and thereafter leave the dial severely alone, with complete confidence that it would be tuned "on the nose" immediately the send/receive switch was operated after a spell of talking.

The remaining two valves in the set are 1.4 volt miniatures, connected as a two-stage audio amplifier. In the "receive" position they do duty as audio amplifiers, following the super-regenerative detector, and on "transmit" they become speech-amplifier and modulator respectively.

By means of one or two cunning dodges, the switching required to accomplish this is reduced to a bare minimum, as a glance at the circuit diagram will show. Only three on/off switches are needed, and these can easily be combined in a P. & T. lever-type switch which can be got (ex ZC1 spares) from a number of parts dealers. In fact, the whole equipment makes fairly extensive use of ZC1 parts, which are cheap and effective.

THE CIRCUIT IN DETAIL

Since the transmitter, receiver, and audio sections have been built into a complete equipment, the circuit of the whole has been drawn as one diagram. However, so that those who wish can take the individual parts of the circuit for separate construction, we have enclosed the three main parts in dotted lines, and will describe the parts separately.

THE TRANSMITTER

The transmitter circuit is derived from that of Fig. 2, which is basically similar to one that appeared in Jones's "Radio Handbook," 10th edition. This, in turn, is developed from the more usual U.H.F. oscillator circuit, which is the one used for the detector, V_3, in the main circuit diagram, Fig. 1. In the latter circuit a short-circuited quarter-wave line is used as a tuned circuit and connected between plate and grid in the same way as the conventional tuned circuit of the so-called ultra-audion oscillator circuit. The circuit of Fig. 2 differs from this only in using an open-circuited half-wave line for the tuned element. This enables the lines to be made much longer for a given oscillator frequency, and also results in a much livelier and more efficient oscillator. Now, if the transmitter circuit is examined together with that of Fig. 2, it will be seen that they are identical except for the addition of a second valve across the open end of the line. In this way, the advantages of the half-wave line are retained, and the power output is doubled compared with the one-valve circuit. This does not occur at these frequencies when an attempt is made to increase the power output by either parallel or more conventional push-pull connection of the two valves. The reason for the extra efficiency of this circuit is to be found in the fact that each valve has its inter-electrode capacities shunted across its own separate piece of line, because if only the one quarter section is used, the capacities of the two tubes would cause the line efficiency to be less, and this would counteract the greater D.C. power input given by using two valves. Here, however, the two-valve is just as efficient as the single-valve circuit, so that the advantage of using two valves is not lost. Another advantage of the circuit which uses a half-wave open-circuited line instead of a shorted quarter-wave section is that it enables the electrodes to be series fed. This is a further saving in losses, since effective isolation of R.F. voltages from the power supply no longer depends completely on the efficiency of R.F.

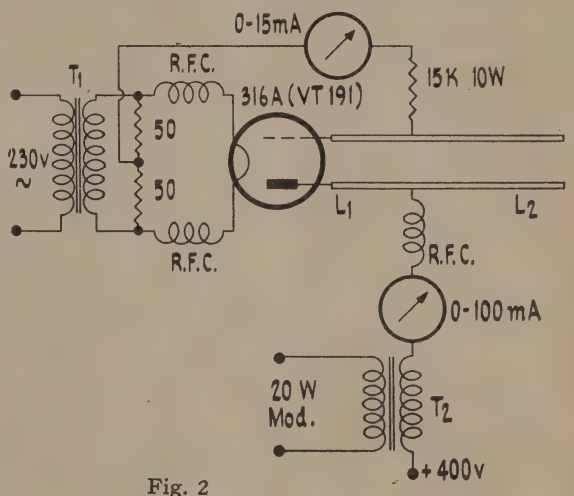

Fig. 2

Suitable transmitting circuit for a fixed station, capable of approximately 8 watts output on 420 mc/sec. Chokes R.F.C. can be similar to those described on the next page for RFC$_1$, etc., on the main circuit diagram. The lines, L$_1$, L$_2$, are approximately 10 in. long, with spacing $\frac{3}{4}$ in.

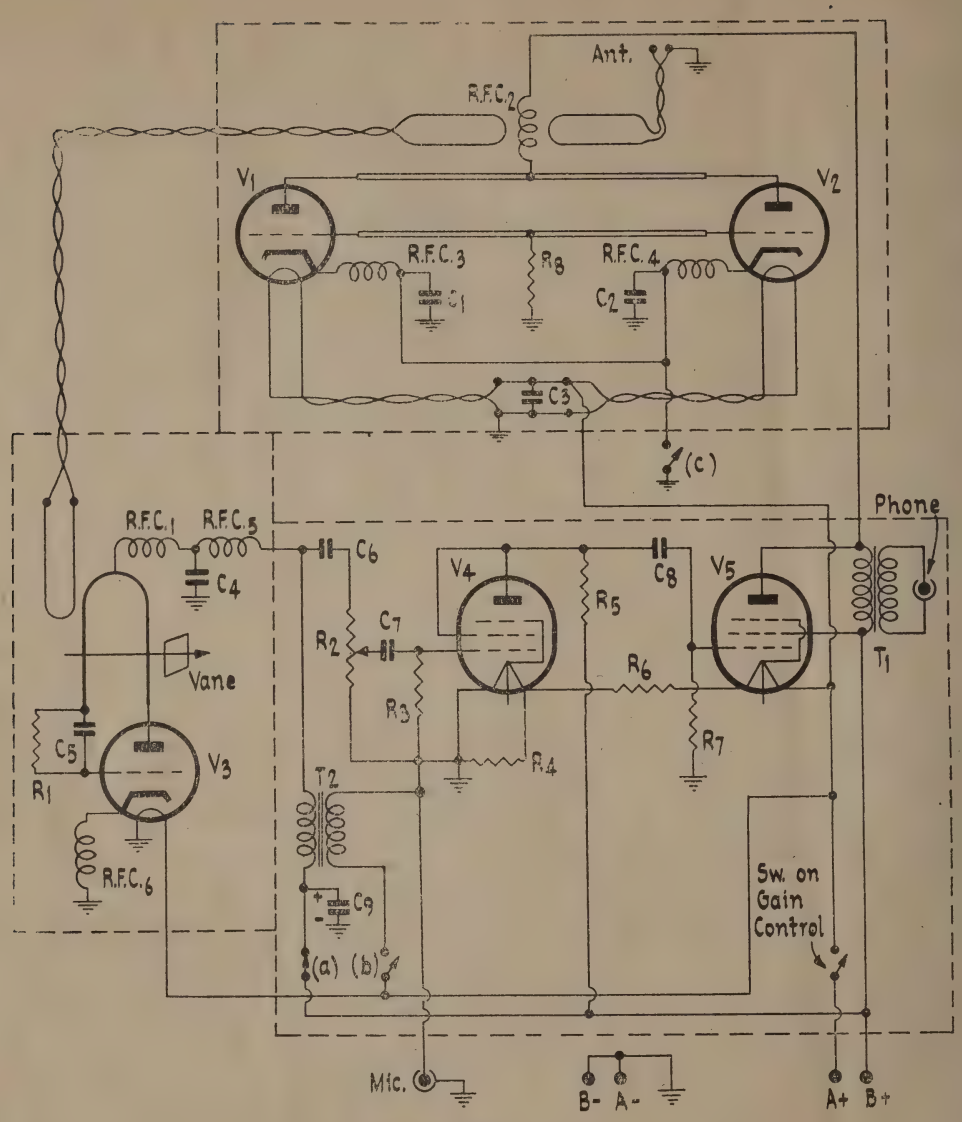

Fig. 1

COMPONENT LIST

V_1, V_2, V_3, 955.
V_4, 3S4 or 3V4.
V_5, 3V4.
RFC_1, RFC_2, RFC_3, RFC_4, 12 turns of 20-gauge en. wire, ¼ in. diam. form.
RFC_5, 10 mH. b/c choke.
RFC_6, same wire, same diam. form as RFC_1, etc., but only 6 turns.
R_1, 500k.
R_2, 500k. pot.
R_3, 10 meg.
R_4, 500 ohms.
R_5, 250k.
R_6, 10 ohms.
R_7, 1 meg.
R_8, 5k.
C_1, C_2, C_3, 15 $\mu\mu$f. midget silvered ceramic.
C_4, 0.004 μf. mica.
C_5, 30 $\mu\mu$f. (two $\mu\mu$f. midget silvered ceramics in parl.)
C_6, C_7, C_8, 0.003 μf. paper.
C_9, 16 μf. high-voltage electro.

chokes. In the transmitter circuit, both grid and plate circuits are series fed, at the exact centre of the line, which is a point of zero R.F. potential. Theoretically, of course, there should be no need for an R.F. choke, even in the plate circuit, but in practie a small amount of R.F. still exists, even at the centre of the line, so that the choke is necessary for proper isola- of the power supply from the R.F. Even so, the main advantage is gained—namely, that the whole R.F. output is not placed across an R.F. choke, with the result that losses are less and efficiency is higher. It will be seen that no choke has been used in the grid circuit, but the grid leak resistor itself is connected from the centre of the line to earth. It was found that no better operation resulted from inserting an R.F. choke in series with the resistor, thus proving that our contention above is amply justified.

A requirement of the circuit, however, is that the cathodes of the oscillator valves shall be allowed to "float." That is to say, they are at some R.F. potential above ground, and all possible precautions must be taken to see that nothing prevents them from being above ground to R.F. In other words, chokes must be placed in the cathode leads, and also there must be no bypass condensers, intentional or otherwise, from cathode to earth. An unintentional bypass condenser exists in the valve itself—namely, the heater-cathode capacity. At lower radio frequencies, this capacity is so small that its bypassing effect can be ignored, but on 420 its reactance is small enough for it to prevent the cathode from assuming its R.F. potential above ground, unless we do something about it. As a first step, R.F. chokes, identical with those in the cathode leads, were inserted in series with the heater leads, but it was found impossible to make the chokes effective on account of the length of the filament leads, and the ends of these chokes remote from the valve pins were found to be at a high R.F. potential, instead of being at zero R.F. potential, as they should have been.

The difficulty was finally solved by using a trick that does not show on the circuit diagram. Some P.V.C. stranded hook-up wire was made into a twisted pair, and exactly 7 in. was cut off for each heater lead. That is to say, the length of the twisted pair from each valve to the bypass condenser, C_3, was exactly 7 in., which is a quarter wavelength at the mid-frequency of the band. Tie points were provided for the condenser and the junction of the individual leads, and at this point one of the leads was earthed. It was then found that the junction of the heater leads was quite "cold," and that, with this arrangement, the oscillator was much livelier. In the actual lay-out used for the transmitter, the whole 7 in. of heater lead was not needed in order to get from one place to another, but it is important to keep this length of heater lead and simply to place it out of the way of other components. The leads do not need to travel straight to the point of junction, but can be disposed of in any convenient manner. Apart from this one dodge, no trouble of any sort was experienced in getting the oscillator going, and it behaved very well indeed.

It will be noted that the switch for turning the transmitter on and off is in the common cathode lead to the two oscillator valves. The bypass condensers, C_1 and C_2, are taken from the cold end of the R.F. chokes straight to the metal chassis, the wire joining the chokes together can have any convenient length, as can the lead from the junction to the switch section (3).

The lines for the transmitter are made from ¼ in. diameter copper or brass rod or tube, and, as can be seen in the photograph, the rods are soldered directly to the connecting lugs on the sockets. The length can be the same, whatever frequency is chosen for the transmitter, the frequency being adjusted by means of the spacing. Since the rods are so heavy, a considerable variation in spacing can be effected simply by soldering them to different points on the socket lug; a variation of approximately ¼ in. can be got by this means.

VIBRATOR RECEIVER

(Continued from page 7.)

cerned, the resistor is not there, and no negative feedback occurs, as would be the case if the bypass condenser were omitted from this valve.

BYPASSING AND DECOUPLING

It will probably have been noticed that very comprehensive decoupling has been used in the plate circuits of all valves, audio and R.F. alike. The reason for this is not so much one of stability, but rather as an added precaution against vibrator hash. Should any hash remain on the H.T. line (and a small amount is almost inevitable), it will be applied to the grid circuits of all valves except the first, and will be subject to considerable amplification. The 2k. resistors and 0.1 μf. condensers are effective in preventing any hash which may still remain in the H.T. supply from being amplified in this way and being heard in the speaker after passing through the detector. The filter in the plate circuit of V_4 is to guard not

(Continued on Page 48.)

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OUR GOSSIP COLUMN

NATIONAL CARBON NEWS

In November next, Charles Hart, popular sales manager for National Carbon Pty., Ltd., New Zealand, is to return to his native city, Adelaide. Like many other Australians, Charles, who apparently never intended to be a fixture in New Zealand, has formed an affection for New Zealanders, and will leave Wellington with many regrets. In Australia he will take over the sales activities of National Carbon in the Southern and Western States lately in the charge of Jack Carpenter. The latter, who has just arrived in New Zealand, will succeed to Mr. Hart's position here.

In spite of an eventful air trip across the Tasman, Mr. Carpenter soon found himself at home among the Wellington radio fraternity. We are certain that he will fill his new position with distinction and carry on the good work of Charles Hart with every confidence.

Our best wishes go to both these members of "Eveready" in their respective spheres of activity.

* * *

FAREWELL TO NORMAN SWANN

On 14th September, members of the radio industry rolled up in record numbers to say farewell to Norm. Swann. The function was held at "Chaston's Place," a cosy little den, fully equipped with the "necessary" to make any "do" go with a swing.

Speaking on behalf of the manufacturers, Ralph Slade spoke in eulogistic terms of Norm. Swann's service to the industry, and was ably supported by Dud Billing representing the wholesalers and retailers, the party heartily endorsing the speakers by the time-honoured "Hearty Good Fellow cheering." As a parting gift, Norm. was presented with a novel type of drinking cup, inscribed with the names of those present and the following words:—

"Farewell Glass"
Presented to Norman Swann
14/9/49
"The land of the Kiwis" he's leaving;
We wish him all the best:
When he arrives in the land of the Kangaroo,
May he always pass the test:
One glass in the morning,
Another at midday,
Perhaps a couple after tea;
You're sure to feel O.K.

Thanks for a most enjoyable evening go to Ralph Slade and Les Chaston for the organization, and honours of the evening go to Mrs. Les Chaston for the delectable refreshments served.

* * *

TECHNICAL BOOKS

Guest of honour at a farewell dinner held at the Royal Oak Hotel on 19th September was Miss Elsie Norris, of Technical Books, Ltd., who is shortly leaving for an extended tour of the United Kingdom and Europe. When presenting Miss Norris with a travelling satchel on behalf of the management and staff, Mr. John Hogan (managing director) referred to the high esteem in which Miss Norris is held by her fellow-employees and the management. Her knowledge of technical books was of the utmost value to the trade, said Mr. Hogan, adding that she would be missed not only on this account, but also for her genial personality. "Radio and Electronics" extends its warmest wishes to Miss Norris for success in all her future undertakings.

* * *

FAREWELL FUNCTION

An event of considerable importance in the radio trade was held at the Commodore Lounge on the evening of Thursday, 15th September, when the staff of Dominion Radio and Electrical Corp., Ltd., popularly known in the trade as "DRECO," gave a fitting farewell to William J. Blackwell, for the past ten years director and general manager of the company, who is relinquishing his position.

The popularity of Bill Blackwell and the esteem in which his staff have always held him were amply demonstrated throughout the whole evening, culminating in the presentation of one of the most magnificent farewell presents we have ever seen. This took the form of a grandfather clock of striking design, a really outstanding example of the cabinetmaker's art. The presentation was made on behalf of the staff by the secretary of the Company, Mr. T. R. Godby, who incidentally has been apopinted manager. A bouquet of flowers was presented to Mrs. Blackwell by Miss Mavis Collins, of Dreco staff.

* * *

Recent visitors to Wellington have included Ted Woods (of Auckland), Dave Nicholson (of Nelson), Mr. Reid (of Eclipse Radio, Dunedin), Fred Beattie (of Wairoa), and George eBnson (of Auckland).

* * *

J. Russell Hancock, Ltd., announce the appointment of Electronic and General Industries, Ltd., as the sole New Zealand distributors to the radio industry for Spire Speed Nuts, products of Simmonds Aerocessories, Ltd., of Great Britain.

* * *

PUBLICATIONS RECEIVED

"Brimistors by Brimar," issued by Standard Telephones and Cables, Ltd., is a folder containing technical information and characteristic curves of "Brimistors," the trade name given to Brimar current surge limiting resistors. The latter should prove invaluable in applications where valve heaters are connected in series. The surge-limiting resistor effectively prevents the initial surge of current through the series heater circuit on first switching on, thereby much improving the life of valves connected in this manner. Fve types are listed covering steady currents from 0.1 amps. to 1.5 amps.

From Arnold & Wright, Ltd., we have received Eddystone catalogues dealing with shortwave components, a shortwave manual, and a brochure entitled "Communications Receiver Model 680."

"Clix," a leaflet on the B7G valve holder, published by the British Mechanical Productions, Ltd., has been received recently, as has also "Polytetrafluoroethylene," a brochure dealing with the history and progress of the above.

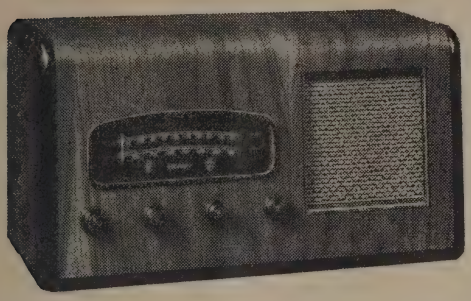
Electronic and General Industries, Ltd., have just released the "Spire" Bulletin No. 101, describing the new and improved version of the "push-on" Spire Speed Fix for the assembly of moulded coil formers.

Giles & Elliott, Ltd., announce that they now have supplies of a brochure entitled "The Sound Mirror Magnetic Tape Recorder," which specially features the advantages for use of this system in education, business, politics, and institutional activities.

NEW PRODUCTS : LATEST RELEASES IN ELECTRONIC EQUIPMENT

COURTENAY MODEL 166 "COSSACK"

(Turnbull & Jones, Ltd.)



The Courtenay model 166 "Cossack" is the newest release in the latest series of Courtenay radios. This model is a 6-valve two-band receiver, using expanded shortwave tuning, and is notable for its very high sensitivity both on broadcast and shortwave bands, combined with extremely good signal-to-noise ratio. The sensitivity (microvolts input for standard output 50 milliwatts) over the broadcast band is better than 1 microvolt, and on shortwave is 1 microvolt at the high-frequency end of the dial, falling to 2 microvolts at the low-frequency end of the scale.

The tube line-up is: 6U76, R.F.; 6K8GT, mixer/osc.; 6U7G, I.F. amp.; 6Q7GT, second det./audio amp./A.V.C.; 6V6GT, output; 5Y3GT, rectifier.

The chassis is a one-piece pressed steel unit of high rigidity, and the tuning unit is unusual in that the variable condenser, wave-change switch, and coil unit form one complete sub-assembly mounted as a "floating unit" on the chassis proper. All trimming and padding adjustments are available from the top of the chassis. Speaker is 8 in. E.M. "Miller effect" tone control, and A.C. switch on volume control complete the features on what must be regarded as a very sound engineering production.

The cabinet is streamlined and finished in walnut veneer, with high-gloss piano polish. The front panel is tilted for better dial vision, and the whole appearance is unusual and refreshing in its simplicity. The distributors, Turnbull & Jones, Ltd., report that this model is pushing sales well up on previous figures.

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5-Valve Portable

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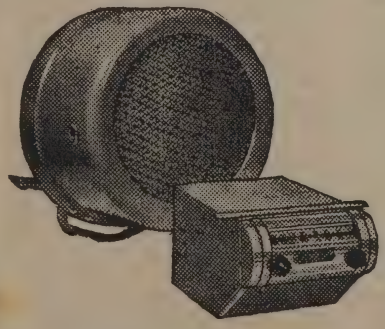

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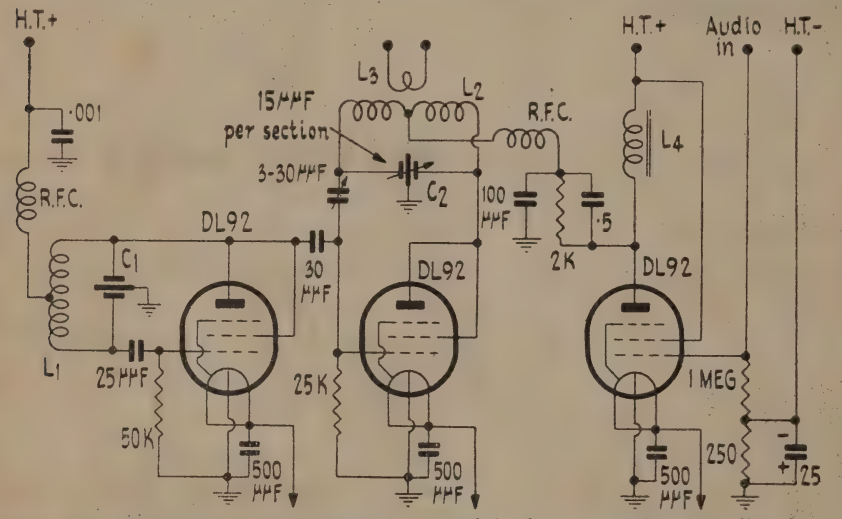
The PHILIPS Experimenter

No. 24: A MINIATURE M.O.P.A. TRANSMITTER FOR BATTERY-OPERATED TRANSMITTERS OR TRANSMITTER-RECEIVERS

With the advent of miniature valves, it is a comparatively simple matter to design small transmitters, with output powers of a few milliwatts and more, that are not only extremely compact, but also light on battery consumption and efficient in operation. The small transmitter-receiver can find a multitude of applications, but hitherto it has suffered somewhat from the use of the one oscillator valve as either transmitter or receiver in the same equipment. This arrangement has become known as the "transceiver," and has a number of serious disadvantages. The worst of them is that it is virtually impossible for two such transceivers, working together, to keep to a given spot frequency. The reason for this is to be found in the fact that when one switches from "transmit" to "receive," the next step, taken automatically, is to tune the receiver, thus destroying the dial setting that was previously used for transmitting. Moreover, this re-tuning is necessary if communication is to be preserved, since there is an inevitable small change in frequency when an oscillator is switched from its ordinary condition to one in which it acts as a super-regenerative receiver. The net result of all this is that the two transceivers "chase" each other one way or another across the tuning dial until at last one of them is at the extreme end of its tunable range.

Until the miniature valve became a commonplace, it was not very practicable to attempt portable battery-operated equipment that was more advanced than the simple transceiver, although some manufacturers and amateurs overcame the most serious objection to the transceiver by using separate valves for the transmitting oscillator and the super-regenerative receiver. However, as an illustration of what can be done to improve portable equipment, the above transmitting circuit was designed. It can form the basis of an excellent transmitter receiver.



CIRCUIT

The R.F. part of the transmitter consists of an M.O.P.A. arangement, using DL92's in both stages. The grid leak is 50k. ohms, and is returned to filament instead of to H.T. The oscillator is capacity-coupled to a further DL92, which is conected as a neutralized amplifier. Both oscillator and amplifier valves are triode-connected. In the case of the amplifier, triode connection was considered preferable, since it is doubtful whether the internal shielding is adequate for the valve to be used as a pentode without undue regeneration. Plate neutralization was used, and was found to be every bit as easy to adjust as the same circuit, when used on low frequencies with normal-sized valves.

The modulator is a third DL92, and this is arranged as a Heising modulator, the 2k. dropping resistor ensuring that the modulated amplifier gets a slightly lower plate voltage than the modulator itself. This circuit is capable of 100 per cent. modulation with good audio quality, and with very small frequency modulation. It is possible to copy it on a receiver whose selectivity is too great to allow a modulated oscillator to be used as the transmitter.

USE IN A COMPLETE TRANSMITTER-RECEIVER

It might appear at first sight that the current consumption of the transmitter might be rather great for miniature batteries to be used, and that, as a result, the portable equipment would have to be rather on the large side. This is hardly the case, however, when it is realized that the transmitter is on only for comparatively brief periods in the course of normal operation. The DL92 filaments have been shown in the parallel connection, making the total filament consumption 0.3 amps. This could be reduced to 0.15 amps. by using the series connection, but the wattage remains the same whichever way the connection is made. In a complete transmitter-receiver circuit, the modulator could also do duty as the audio amplifier stage following the detector.

Thus, as long as a high-output microphone is used, such as a single-button carbon type, the complete transmitter-receiver could consist of four DL92's, two of which would be in use on "receive" and three on the "transmit" position of the transmit/receive switch. Since this uses only an audio amplifier as a stage common to both positions of the switch, none of the disadvantages of transceiver operation apply.

Thus, the "receive" position would have a filament drain of 0.2 amp. or 0.1 amp., according to whether series or parallel operation of the filaments was used. In the series case, a 3-volt cycle battery would give very good A battery life, and would still enable a compact design to be used.

On account of the quick-heating properties of the filament valves used throughout, it would be entirely practicable to use a filament switch to change from transmit to receive, thereby simplifying the switching and economizing on battery drain during receiving or stand-by periods.

OPERATING FREQUENCY

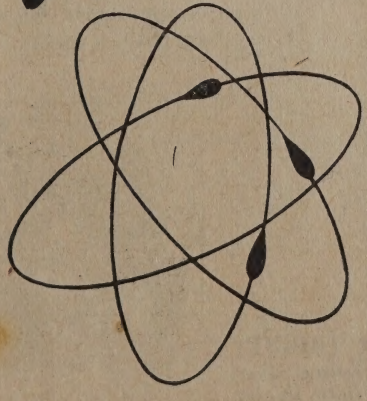
The above circuit has been used successfully on the 50-54 mc/sec. amateur band, and, with an H.T. voltage of 67.5, gave a measured carrier output of 50 milliwatts. It is not recommended that attempts be made to use the DL92 on higher frequencies unless more driving power is available. In the experimental version of the circuit that was constructed, it was apparent that the power output could have been greater had more driving power been available from the oscillator, so that the latter is really the limiting factor in trying to use the circuit at higher frequencies. There is no need, however, to use an H.T. voltage as high as 67.5, which is the rated maximum for the valves, and, in point of fact, excellent performance was obtained with 45 volts and no circuit changes whatever. This shows that useful power output, with good modulation characteristics, will be obtained even if a 67.5 volt battery is well run down, near the end of its life.

CIRCUIT CONSTANTS FOR THE 6-METRE BAND

The circuit values for putting the transmitter on the 50-54 mc/sec. band are as follows:—

C_1, split stator, 50 $\mu\mu$f. max. capacity per section.
C_2, split stator, 25 $\mu\mu$f. max. capacity per section.
L_1, 7 turns 16-gauge bare copper, $\frac{5}{8}$ in. long, $\frac{1}{2}$ in. diameter, tapped at centre.
L_2, 10 turns 16-gauge bare copper, $1\frac{3}{8}$ in. long, $\frac{1}{2}$ in. diameter, with a $\frac{3}{8}$ in. gap between the two halves.
L_3, 2 turns 16-gauge bare copper, aerial coupling link.
R.F.C., 100 turns 30-gauge en., close-wound on 1-watt resistor as former.
L_4, 30 ma. vibrator smoothing choke, or similar, modulation choke.

PHILIPS "Miniwatt" VALVES



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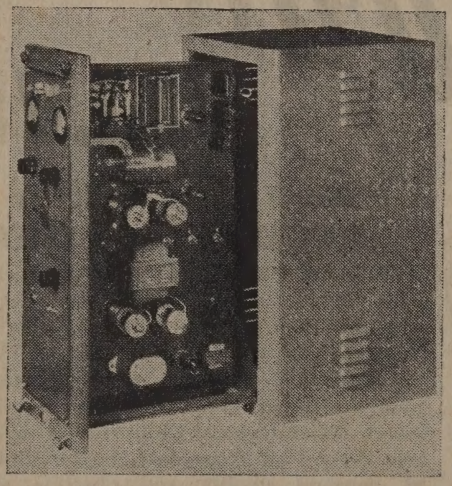
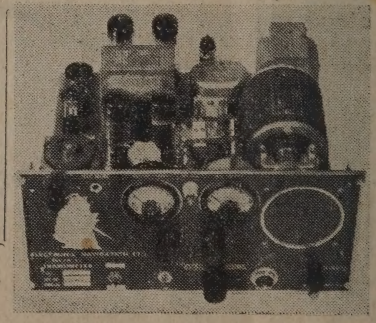
RADIO PHONE TRANSMITTER



(1) Three-channel, crystal controlled
(2) Frequency range, 1.5 to 4 mc/sec.
(3) Power output, 65 watts in Ant.
(4) Battery or mains operated



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ADJUSTMENT

Adjustment of this presents no difficulties at all, and exactly the usual methods can be used in neutralizing the amplifier stage. A 0-1 ma. meter can be connected at the "cold" end of the amplifier grid leak to act as a neutralizing indicator and to show the output of the oscillator. With the H.T. disconnected from the amplifier, the neutralizing condenser can be adjusted until tuning the plate condenser through resonance gives a minimum effect on the grid current. As long as all R.F. leads are kept short, neutralization will be easily found, and the Philips trimmer sealed in position with wax. After this has been done, it is a good plan to connect a milliammeter in the plate feed of the amplifier and find resonance by tuning for minimum plate current, just as in a full-sized stage. The aerial can then be coupled in and the amplifier re-tuned for the new dip in plate current. After a suitable degree of coupling has been found, the coupling loop can be set in position permanently, after which no change will be necessary if the oscillator frequency is altered to another place in the band.

OPERATING CURRENTS

With 67.5 volts of H.T., the total current drain of the transmitter is 26 ma., comprising 9 ma. in the oscillator, 8 ma. in the final, and 9 ma. in the modulator. At this, the power output is 50 milliwatts, and is enough to show a dull red glow in a 150 ma. 6.3v. panel lamp. At an H.T. voltage of 45, the total drain is 17.5 ma., made up of 6.5 ma. in the oscillator, 5.2 ma. in the final, and 5.8 ma. in the modulator.

With the 67v. and 45v. H.T. supplies, the oscillator grid current was 0.44 ma. and 0.25 ma. respectively. The power output was not measured with the lower plate voltage, an accurate measurement not being feasible with the equipment available.

SOME POINTS ABOUT OPERATION

As will be seen, the H.T. drain of the transmitter is not exactly light, especially if midget batteries are to be used. However, the drain is not excessive when it is remembered that the transmitter is in operation only intermittently, and if the on periods are kept reasonably short, as good operating practice recommends. The equipment itself can be made so small that there would be no difficulty in a "walkie-talkie" style of construction, in incorporating larger H.T. batteries in order to reduce the frequency of battery replacements. The bulk of the time of operation is spent with the receiver only on, in which case the H.T. drain will be only 6 ma. with 45v. and 10 ma. with 67.5v., assuming that the receiver consists of a DL92 super-regenerative detector, followed by the modulator valve switched in as the audio amplifier stage.

In coupling in the aerial, it should be realized that no useful purpose is served by over-coupling. If a lamp indicator is used, it will be found that there is an optimum value of coupling beyond which the output drops off. It is particularly important to see that this value of coupling is not exceeded, for, if it is, positive peak flattening will occur on modulation and proper 100 per cent. modulation will not be obtainable. If the transmitter is set up with the aid of an oscilloscope, just as if it were a full-sized one, it will be found that an excellent modulation pattern can be obtained.

Briefly, this transmitter is a properly designed miniature, exactly following full-sized practice, and one should not make the mistake of assuming that any rough adjustment will do on account of its small size and minute power output. If all adjustments are carried out exactly as for a normal transmitter, it will be found that, except for the small power output, the performance will be similar in all respects to that of a larger one, and that communication results far exceed those from a self-excited modulated oscillator of several times the power input.

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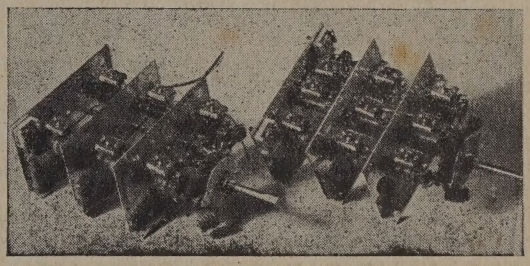

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A NEW WAY OF USING 807'S

(Continued from page 28.)

will not be far out if it is made with the same ratio as for 750 volts—namely, 1 to 1.2, primary to half-secondary.

CONCLUSION

Although, as we have said, the information presented is by no means complete, there is enough of it to indicate that the 807 in this new connection has distinct possibilities as a cheap and easy way of getting high audio power with valves that are at present ridiculously low in price, considering their capabilities.

In fact, for the experimentally inclined, it would appear that here is a field that is well worth exploring. It is for this reason that we have published what information we have rather than waiting until our own experimental work has enabled more complete data to be presented.

QUESTIONS AND ANSWERS

(Continued from page 31.)

high-quality output transformers on the market which are specifically designed for this plate-to-plate load impedance, which readers will recognize as the recommended value for 6L6's under certain conditions. Thus, this amplifier is able to use a stock transformer which makes the parts easier to acquire. The decrease in distortion caused by using the higher impedance is very well worth while in an application like this.

AUCKLAND RADIO TRADERS' ASSN.

(Continued from page 35.)

held in Mexico City. Faced with the formidable task of allotting to 60 nations their requirements in the high-frequency spectrum—requirements which were many times greater than the total hours of broadcasting in these bands—the conference spent many months reconciling conflicting views, and eventually managed to straighten out what had threatened to be a chaotic state of affairs. New Zealand fared remarkably well, and was greatly helped by its geographical location, which enabled it to share frequencies which are used at other times by European nations. Mr. Harrison also explained the difficulties facing any attempts to exploit television in this country, and estimated, as a minimum cost of installing transmitters in the four main centres, an expenditure of £1,000,000, with a further £500,000 required annually. There were no great technical difficulties, he said, but the economic problems were likely to remain as stumbling-blocks for many years to come.

420 MC/SEC. TRANSMITTER

(Continued from page 42.)

of the chassis near the volume control potentiometer is due to the soldering of the shaft of this component to the front edge of the hole. This is necessary only to enable the shaft to be put through the hole in the front of the box, after which the nut is put on in the ordinary way.

We have already been asked why the 955 sockets of the transmitter portion are mounted in opposite directions. The reason is, of course, that there are no left and right-handed valves made as yet, so that the sockets had to be mounted this way in order to bring plate and grid connections to the right sides of the line. Because of the way in which the whole is put together, there is no difficulty about finding room above the chassis, as the general top-chassis photograph might tend to suggest. The only congested area is below the chassis, where most of the space is fully occupied, but not unduly so.

PUTTING THE SET INTO OPERATION

Since the set consists of three really independent units, and because the switching is so simple, there should be no difficulty at all in wiring them separately and, for a start, making them work as independent items. In this way, the transmitter can be used as a source of signal.

VIBRATOR RECEIVER

(Continued from page 41)

against R.F. noise from the vibrator, but from audio frequency noise, which occurs at the same time in all vibrator circuits. It will be seen that the choke L_1 and the electrolytic condensers C_{25} and C_{26} are arranged as a low-frequency filter in the H.T. line just as in the case of an ordinary rectifier. This takes care of the bulk of the ripple (at the frequency of the vibrator), but the RC filter in the plate of the 6AV6 is another precaution preventing any residual ripple from being applied to the grid of the 6V6 and being amplified by it.

(To be continued.)

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